

TENTH BIENNIAL



WESTERN STATES & PROVINCES
DEER & ELK WORKSHOP
MONTANA ★ 2013



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TENTH BIENNIAL WESTERN STATES & PROVINCES DEER & ELK WORKSHOP

Time	Monday, May 6	
1:00-5:00 p.m.	Mule deer working group meeting	
5:00-8:00 p.m.	Registration	
5:00-6:00 p.m.	Poster Session	
6:00-8:00 p.m.	EVENING SOCIAL (included with registration)	
Time	Tuesday, May 7	
7:30-10:00 a.m.	Registration continues	
7:00-8:00 a.m.	BREAKFAST (included with registration)	
	Session 1 Room A - Plenary Session, Moderator Mark Hebblewhite	
8:00-8:30 a.m.	Opening remarks/welcome Jeff Hagener, Director Montana Fish, Wildlife & Parks	
8:30-8:35 a.m.	Introduction to plenary session and participants	
8:35-9:05 a.m.	Bruce Johnson - Influence of habitat, weather, nutrition, carnivores, and hunting in limiting elk populations in a relatively mild and variable weather environment with a limited complement of large carnivores: Oregon	
9:05-9:35 a.m.	P. J. White and Bob Garrott - A synthesis of elk research on Yellowstone's central and northern ranges over the past two decades	
9:35-10:05 a.m.	Eric Bergman and Andy Holland – Influence of habitat, weather, nutrition, carnivores, and hunting in limiting mule deer populations in a relatively mild weather environment, a limited complement of carnivores, and management focused on quality hunting experiences	
10:05-10:35 a.m.	Mark Hurley and Toby Boudreau - Influence of habitat, weather, nutrition, carnivores, and hunting in limiting mule deer populations in a variable weather environment, a full complement of carnivores, and management focused on providing hunter opportunity	
10:35-11:05 a.m.	George Pauley and Ken Hamlin - History of deer and elk management in Montana, with reference to how habitat, nutrition, weather, hunting, and carnivores have been considered, as an example of the evolution of management in the contiguous states	
11:05-11:35 a.m.	Jim Allen - History of deer and elk management in Alberta, Canada, with reference to how habitat, nutrition, weather, hunting, and carnivores have been considered, as an example of the evolution of management in Canada.	
11:35-12:00 p.m.	Questions and discussion	
12:00-1:00 p.m.	LUNCH (included with registration)	
	Session 2 Room A - State & Province Status Updates, Moderator: Mike Mitchell	Session 2 Room B - State & Province Status Updates, Moderator: John Vore
1:00-1:25 p.m.	Rob Corrigan - Status of deer and elk populations in Alberta	Carlos López-González – Abundance and density of mule deer in northern Sonora and Chihuahua, México
1:25-1:50 p.m.	Eric Bergman - Colorado deer and elk population and inventory summary	Stewart Liley - Status of deer and elk in New Mexico, 1995-2011
1:50-2:15 p.m.	Quentin Kujala - Status of deer and elk populations in Montana, 1960-2012	Shawn Gray - Status of deer and elk populations in Texas, 2005-2011
2:15-2:40 p.m.	Will Schultz – Status of deer and elk in Wyoming, 1990-2013	Anis Aoude - Status of deer and elk in Utah, 1990-2013
2:40-3:05 p.m.	Andy Lindbloom - Status of deer and elk populations in South Dakota, 2002-2011	Brian Wakeling - Status of deer and elk in Arizona, 2013
3:05-3:25 p.m.	BREAK	BREAK
	Session 3 Room A - State & Province Status Updates, Moderator: Bruce Johnson	Session 3 Room B - State & Province Status Updates, Moderator: Vanna Boccadori
3:25-3:50 p.m.	Toby Boudreau - Status of deer and elk populations in Idaho, 2000-2013	Lloyd Fox and Matt Peek - Status of deer and elk populations in Kansas
3:50-4:15 p.m.	Daryl W. Lutz – Mule deer management in Wyoming: The paradigm of a public owned resource	Kit Hams - Status of deer and elk populations in Nebraska
4:15-4:40 p.m.	Gerald Kuzyk - Challenges to increasing mule deer abundance in British Columbia	Terri Weist – Status of deer and elk populations in California, 2000-2012



TENTH BIENNIAL WESTERN STATES & PROVINCES DEER & ELK WORKSHOP

Time	Tuesday, May 8 (Continued)	
4:40-5:00 p.m.	Don Whittaker – Status of deer and elk populations in Oregon.	Tony Wasley - Current Status of deer and elk populations in Nevada
5:00-6:00 p.m.	State & Provincial Business Meeting	
6:00-8:30 p.m.	DINNER (on your own)	
Time	Wednesday, May 8	
7:00-8:20 a.m.	BREAKFAST (included with registration)	BREAKFAST (included with registration)
	Session 4 Room A - Elk Habitat, Moderator: Mark Hebblewhite	Session 4 Room B - Harvest, Survey and Management, Moderator: Mike Thompson
8:20-8:40 a.m.	Mary Rowland - Modeling elk nutrition and habitat use across large landscapes: New methods of meta-analysis	Paul Krausman – Effects of harvest, culture, and climate on trends in size of horn-like structures in trophy ungulates
8:40-9:00 a.m.	Evelyn Merrill – Forage dynamics related to changing forest practices at Mount St. Helens, Washington	Eric Freeman - Effects of male-biased harvest on mule deer: implications for rates of pregnancy and synchrony/timing of parturition
9:00-9:20 a.m.	Kelly Proffitt – Effects of hunter access and habitat security on elk habitat selection	Mike Lewis – Selected results from resident and nonresident mule deer hunter preferences surveys conducted by Montana Fish, Wildlife & Parks
9:20-9:40 a.m.	Robert Anderson - Theoretical elk habitat change in response to prescribed burning in west-central Alberta	Craig White – 2012 Idaho elk hunter opinions and attitude survey
9:40-10:00 a.m.	Dana Seidel - Influence of foraging behaviour on home range development in elk	Victoria Edwards - Managing the North Hills/Evaro elk herd in the wildland-urban interface of Missoula, MT- adaptive management responses to shifting elk distribution and behavior
10:00-10:20 a.m.	BREAK	BREAK
	Session 5 Room A - Neonate Elk, Moderator: Peter Zager	Session 5 Room B - Human-Ungulate Interactions, Moderator: Vickie Edwards
10:20-10:40 a.m.	Mark Hebblewhite - Evaluating bottom-up and top-down effects on elk survival and recruitment in the Bitterroot Valley: year two update	Steven Belinda - A paradigm shift for mitigation on public lands – Landscape mitigation, mitigation banking, and conservation credits: will mule deer and elk benefit?
10:40-11:00 a.m.	Nicole Tatman Quintana – Elk calf survival and the effectiveness of black bear removal in north-central New Mexico	Marcus Blum - Impacts of Mining on Mule Deer Migrations in Nevada
11:00-11:20 a.m.	Lance Bernal - Cause-specific mortality and survival rates of neonatal elk (<i>Cervus elaphus</i>) on the Valles Caldera National Preserve, New Mexico	Jeffrey Gagnon – Evaluation of an animal activated elk crosswalk and highway fencing retrofit to reduce elk-vehicle collisions in Arizona, USA.
11:20-11:40 a.m.	Mike Ebinger - Geo-statistical methods for detecting elk parturition sites from global positioning system collar data	Jenny Jones - Influence of winter feeding on migration strategies of elk (<i>Cervus elaphus</i>) in west-central Wyoming.
11:40-12:00 p.m.	Stewart Liley – Preliminary observations and discussion on elk parturition above timberline in north-central New Mexico	Colleen Arnison – Pervasive human influences in a terrestrial food web centered on elk
12:00-1:00 p.m.	LUNCH (included with registration)	LUNCH (included with registration)
	Session 6 Room A - Population Dynamics and Predation, Moderator: George Pauley	Session 6 Room B - Disease and Other Topics, Moderator: James Heffelfinger
1:00-1:20 p.m.	Colleen Arnison - Understanding and managing elk decline in Jasper National Park	Paul Rogers – Relative impacts of elk, mule deer, and cattle on aspen habitat in the Book Cliffs, Utah and Colorado



TENTH BIENNIAL WESTERN STATES & PROVINCES DEER & ELK WORKSHOP

Time	Wednesday, May 8 (Continued)	
1:20-1:40 p.m.	Scott Eggeman - Should I stay or should I go? Variation in migratory behavior balances fitness in a partially migratory elk population	Paul Cross – Elk contact patterns and potential disease transmission
1:40-2:00 p.m.	Victoria Edwards - The collapse of the Burdette Creek elk herd in western Montana	Julie Shamhart – Elk movements and brucellosis transmission risk in southwest Montana
2:00-2:20 p.m.	Scott McCorquodale - Abundance, productivity, condition, and survival of Mount St. Helens elk, 2009-2013, and current elk management challenges	Evelyn Merrill – Incorporating movement based-landscape connectivity into assessments of chronic wasting disease risk in the prairie provinces of Canada
2:20-2:40 p.m.	Cody Schroeder - Migration behavior, body condition, and sex differences in survival of mule deer	Teagan Hayes – Elk habitat use on degraded rangeland in the Sapphire Mountains, MT
2:40-3:00 p.m.	BREAK	BREAK
	Session 7 Room A - Mule Deer Habitat, Moderator: Mark Hurley	Session 7 Room B - Genetics and Other Topics, Moderator: Paul Cross
3:00-3:20 p.m.	Sophie Gilbert – Population dynamics of a forest ungulate respond to winter severity and habitat alteration	Kenneth Warheit – Genetic structure and diversity of elk (<i>Cervus elaphus</i>) in Washington State
3:20-3:40 p.m.	Lisa Shipley – Effects of spring cattle grazing on the nutrition of mule deer in a bluebunch wheatgrass community	James Heffelfinger - Hybrid swarm between divergent lineages of mule deer (<i>Odocoileus hemionus</i>)
3:40-4:00 p.m.	Grant Sorensen - Nutritional condition of adult mule deer following habitat enhancements in north-central New Mexico	James Heffelfinger - Development of genetic markers to identify Coues, Carmen mountain, and other whitetails
4:00-4:20 p.m.	Sonja Smith - Winter habitat use by mule deer in Idaho and Montana	Brock Hoenes - Development of a standardized survey protocol for mule deer herds that winter in the Columbia Plateau ecoregion
4:20-4:40 p.m.	Andy James - A habitat selectivity index for desert mule deer in the Apache Mountains of Trans-Pecos, Texas	Adam Gaylord – Ungulate activity classification: calibrating dual-axis activity monitor GPS collars for Rocky Mountain elk and mule deer
6:00-8:30 p.m.	BANQUET (included with registration) Presentation of the Wallmo Award Banquet Speaker: Susan Flader - Leopold's 'Thinking Like a Mountain' Revisited	
Time	Thursday, May 9	
7:00-8:30 a.m.	BREAKFAST (included with registration)	
	Session 8 Room A – Plenary Presentation/Panel Discussion, Moderator: Julie Cunningham	
8:30-9:30 a.m.	Wildlife managers and administrators: Jim Hayden, Jerry Nelson, Stewart Liley, Mike Thompson, Thomas Thornton, & Brian Wakeling – Restoring deer and elk again, in the era of overabundance – Is there a will, and what will it take?	
9:30-10:00 a.m.	BREAK	
	Session 9 Room A - Elk and Deer Presentations, Moderator: Sonja Smith	
10:00-10:20 a.m.	Tom Toman - Habitat enhancement strategy changes in elk country	
10:20-10:40 a.m.	Eric Bergman - Effect of habitat management on overwinter survival of mule deer fawns in Colorado	
10:40-11:00 a.m.	Julie Cunningham - Bottom-up and top-down effects on northern Yellowstone elk pregnancy and recruitment rates	
11:00-11:20 a.m.	Pete Zager - Untangling Rocky Mountain elk ecology and population dynamics: a regional synthesis across the northwestern U.S.	
11:20-11:40 a.m.	Paul Lukacs - The Montana deer and elk hunting population: Importance of cohort group, license price, and population demographics on hunter retention, recruitment, and population change	
11:40-12:00 p.m.	Simone Ciuti - Trade-offs between predation risk and food quality re-distribute elk across a road network: not all roads are equal	
12:00-1:00 p.m.	LUNCH (included with registration)	

Abstracts – Status Reports, 2013

Alphabetical by State, Province or Country



STATUS OF DEER AND ELK POPULATIONS IN ALBERTA

ROB CORRIGAN, Alberta Environment and Sustainable Resource Development, Wildlife Management Branch, 2nd Floor GWL 9920-108 St., Edmonton, AB, T5K 2M4, (780) 644-8011, rob.corrigan@gov.ab.ca

JIM ALLEN, Alberta Environment and Sustainable Resource Development, Wildlife Management Branch, 2nd Floor GWL 9920-108 St., Edmonton, AB, T5K 2M4, (780) 427-4194, james.allen@gov.ab.ca

Abstract: Provincial populations of white-tailed deer (235,000), mule deer (142,000) and elk (33,000) have been increasing over the past 20 years. Despite increasing provincial populations, some areas of Alberta have experienced significant declines in elk number, including core population of elk in the mountains and east slopes of west central Alberta. Population declines of elk in the west central part of Alberta are largely attributed to increasing predation by grizzly bears and cougars. Elk range has recently expanded into the prairies and central parkland eco-regions of Alberta. Increased distribution has led to new hunting opportunities but also is causing significant issues with agricultural producers. White-tailed deer and mule deer suffered significant regional winter mortality during the winter of 2010-11. High winter mortality has reduced populations below desired goals in many areas of the province. In response to below goal population levels, recreational hunting opportunities were reduced in many areas of the province. Mule deer hunting in Alberta has also undergone significant changes in response to increasing harvest of antlered mule deer by bow hunters. In order to equitably distribute harvest amongst user groups, archery hunting for antlered mule deer will now require a special licence throughout much of Alberta. Historically bow hunters have been able to hunt antlered mule deer with a general licence. Chronic Wasting Disease (CWD) in mule deer continues to increase in prevalence along the eastern border of Alberta and is moving west along major drainage systems.

Presenter: ROB CORRIGAN, Provincial Big Game Specialist

STATUS OF DEER AND ELK IN ARIZONA, 2013

BRIAN F. WAKELING, Arizona Game and Fish Department, Game Branch, 5000 West Carefree Highway, Phoenix, AZ, 85086, (623) 236-7385, bwakeling@azgfd.gov

AMBER A. MUNIG, Arizona Game and Fish Department, Game Branch, 5000 West Carefree Highway, Phoenix, AZ 85086, (623) 236-7355, amunig@azgfd.gov

Abstract: Deer and elk population levels exhibited independent patterns over the past 20 years. Elk numbers probably peaked in the early 1990s, but harvest was used to reduce their numbers. Their population levels have remained stable since about 2000. Mule and white-tailed deer populations reached the most recent peak in the early 1980s. Mule deer declined through about 2000 and since then have probably increased by about 10%. White-tailed deer followed a similar trend, although the decline was not as pronounced. Most deer populations within the state are surveyed annually using fixed-wing aircraft or helicopter, and an increasing proportion of elk populations as well. Supplemental ground surveys are used as well. All cervids are surveyed during the breeding season to estimate male to female and young to female ratios. Hunter harvest is estimated using a voluntary post card questionnaire that may be returned with postage prepaid or responses may be entered online. Currently, we receive about 35–55% response rate, with about 15–20% of all responses online. General



deer harvest was about 19,000 animals in 1989, but last year harvest was estimated at just over 9,000. General elk harvest was about 5,000 animals in 1989, whereas harvest estimates for last year were about 6,200. Buck to doe ratios for both mule and white-tailed deer are managed at 20–30:100, whereas elk bull to cow ratios are managed at 25–35:100. For deer and elk, alternative management units are managed at higher male to female ratios with added guidelines regarding the age structure of the harvest or hunter density. These units approximate about 5% of the opportunity offered annually. Recent wildfires have created situations that are favorable to improved growth of deer and elk populations, yet limited land management actions (e.g., prescribed fire, thinning) benefiting forage production are implemented annually.

Presenter: BRIAN F. WAKELING, Arizona Game and Fish Department

CHALLENGES TO INCREASING MULE DEER ABUNDANCE IN BRITISH COLUMBIA

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AARON REID, Ministry of Forests, Lands and Natural Resource Operations, Suite 401-333 Victoria Street, Nelson, BC, V1L 4K3, Canada, Aaron.Reid@gov.bc.ca

Abstract: Hunters are central to the North American Model of Wildlife Conservation so maintaining or increasing hunter opportunity is a key focus of wildlife managers. In British Columbia, mule deer live in a diversity of habitats and are a widely sought after species by hunters for both meat and trophy opportunities. Mule deer abundance varies from increasing to decreasing throughout the province and these differences can result in divergent harvest management strategies. Additional complexities arise with varied stakeholder interests with some requesting maximized hunter opportunities throughout the species range. Determining mechanisms which may limit mule deer population growth in both stable and suppressed populations is expensive, time consuming and mechanisms can vary among landscapes, leaving wildlife managers relying on limited quantitative data combined with scientific literature to base management recommendations. Wildlife managers are often further hampered from implementing management actions that may enhance mule deer abundance due to a lack of consistent management objectives, government policy or legal management levers. In BC there is increased social pressure to enhance mule deer abundance in many parts of the province but limited research exists on mule deer population dynamics. The purpose of this paper is to provide a concise review of potential limiting factors of population abundance of mule deer relevant to BC and discuss these factors in relation to enhancing mule deer abundance relative to available policies and management levers.

Presenter: GERALD KUZYK, Ministry of Forests, Lands and Natural Resource BC, Canada



STATUS OF DEER AND ELK POPULATIONS IN CALIFORNIA, 2000-2012

CRAIG STOWERS, California Department of Fish & Wildlife. 1812 9th Street Sacramento, CA 95758 (916) 445-3553. Craig.stowers@wildlife.ca.gov.

Abstract: California's deer population has varied between stable to moderately declining over the last 20 years. Migratory deer populations in the northern and eastern parts of the state have shown the biggest decline. Data collection methods include aerial and ground counts to determine population composition. The KILLVARY model is used to estimate populations using harvest and herd composition data. Regulations do not require reporting by non-successful hunters. We have a new on-line reporting system and are working on regulations to require mandatory reporting by all deer hunters for the 2014 hunting season. The vast majority of our tags are issued on an "over-the-counter" basis to provide maximum hunter opportunity. Premium hunt zones and late season hunts are issued through a public drawing based on a modified preference point system. CDFW has 88 separate deer herd plans. These individual herd plans and the state wide management plan are outdated and are currently being revised and updated. CDFW switched to an electronic application system which allows us to identify our entire population of deer hunters. We have recently provided an on-line harvest reporting option which will lead to large savings in staff time. We are developing a new state-wide deer conservation plan which will lead to development of individual conservation area plans. Our recent experience with OR7 has ignited a new interest in our ungulate populations but the impact on future management has yet to be determined. A strong anti-hunting segment of CA's population remains very active and is increasingly impacting management decisions.

Presenter: TERRI WEIST, California Department of Fish & Wildlife

COLORADO DEER AND ELK POPULATION AND INVENTORY SUMMARY

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ERIC BERGMAN, Colorado Parks and Wildlife, 317 West Prospect, Fort Collins CO 80526, (970) 472-4415, eric.bergman@state.co.us

Abstract: The statewide post-hunt 2011 deer population estimate is 418,000, compared to 430,000 in 2010, which is far below the current statewide population objective range of 528,000 - 578,000 for the state's 55 deer Data Analysis Units (DAUs) or herds. Populations have declined in the western portions of the state. Multiple factors are leading to declines in mule deer. Habitat loss to development and fragmentation, declining habitat quality from invasive weeds and fire suppression, the harsh winter of 2007-2008, reduced survival from the winter of 2010-2011 in the extreme NW part of the state, and lasting effects from the drought all contribute in varying degrees to population declines. Some deer herds in the central and northern mountains also are performing well, and population sizes are increasing. Most plains deer populations in the Northeast and Southeast Regions remained relatively stable. Colorado Parks and Wildlife (CPW) conducts post-hunt herd inventories with helicopters to estimate the sex ratios of males/100 females and the age ratios of young/100 females. In addition to survival rates and harvest survey estimates, these ratios are used to estimate population size using



population models. The current weighted average sex ratio objective for DAUs statewide is 30 bucks/100 does. During the post-hunt herd inventories in 2011, CPW employees classified 57,600 deer and observed an average sex ratio (weighted by population size) of 29.4 bucks/100 does, compared to a similar 29.5 bucks/100 does in 2010. Based on observed post-hunt sex ratios and high hunter success, overall buck hunting quality continues to be good, even in some of the declining herds. In these herds, we have lowered license numbers to achieve the sex ratio objectives and maintain quality hunting. The statewide elk population estimate is 265,000 in post-hunt 2011, compared to 282,000 in 2010. The current post-hunt population objective range for elk DAUs statewide is 220,000-260,000. Season and license setting designed to increase antlerless harvest continues to reduce many elk populations, and statewide antlerless harvest remains similar to bull harvest. A reduction in antlerless licenses is anticipated in the future as more populations reach objectives. The predicted 2012 elk harvest is 44,000, which is nearly identical to last year's harvest estimate of 43,500. Bull harvest in 2011 was also nearly identical to 2010 at 21,600. Antlerless harvest was 21,800, an intentional 16% reduction from 26,100 in 2010. The current sex ratio objective range for DAUs statewide is 22-26 bulls/100 cows. Most elk DAUs are near bull/cow ratio objectives. In 2011, during the post-hunt herd inventories, CPW employees classified 70,000 elk and observed an average sex ratio (weighted by population size) of 22.6 bulls/100 cows, down slightly from the 25 bulls/100 cows observed in 2010. This largely was due to the mild weather making it more difficult to find bulls during helicopter inventory because they are in smaller groups and often at higher elevation. The statewide sex ratio has increased over the last two decades. Colorado has a combination of units that are limited in all seasons and units that have both limited and over-the-counter hunting seasons. These options allow us to offer a very wide range of hunting opportunities on one of the nation's premier elk populations.

Presenter: ERIC J. BERGMAN, Colorado Parks and Wildlife

STATUS OF DEER AND ELK POPULATIONS IN IDAHO, 2000-2013

TOBY BOUDREAU, Idaho Department of Fish and Game, 600 South Walnut Street, Boise, ID 83707, (208) 287-2746, toby.boudreau@idfg.idaho.gov

Abstract: Deer and elk population status vary greatly based on geography throughout Idaho. Changes in predator composition and long-term habitat changes are some of the factors influencing declines, in other areas, populations have increased to the point of exceeding social carrying capacity. Harvest trends have shown a general decline in elk harvest as well as stable harvest mule deer and white-tailed deer statewide over the previous decade. The bulk of our surveys are aerial sightability and composition surveys with some added ground surveys in several locales. Harvest information is collected through an automated mandatory harvest reporting system. Maintaining hunter opportunity is the main management strategy in the state, however, we also provide a variety of trophy opportunities for deer and elk. Management programs are guided by our species management plans with a variety of metrics used to manage harvest and opportunity from aerial population and composition surveys, research data, harvest numbers, and antler point counts of harvested males.

Presenter: TOBY BOUDREAU, Idaho Department of Fish and Game



STATUS OF DEER AND ELK POPULATIONS IN KANSAS

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Abstract: Kansas has a small population elk numbering approximately 300. Elk exist on several large public lands, but have become more abundant on private lands in the state in recent years. Since 1999, more liberal hunting opportunities have been authorized on private lands to allow landowners to maintain elk at desirable numbers on their own property while at the same time allowing the public lands herds to be maintained. Deer populations in Kansas increased dramatically from the 1960 through 2000 primarily because of an increase in white-tailed deer. Large areas enrolled in CRP during the 1980s and 90s probably influenced recruitment. Since 2000 the populations have remained stable as a result of increased hunting pressure placed on antlerless white-tailed deer. Harvest followed population trends from 1,500 in 1965 to more than 100,000 in 2000. The number of mule deer taken annually since 1985 has remained stable at approximately 3,000. Management has traditionally been influenced by social factors instead of habitat or deer population objectives. Open permit access is allowed for all residents. Seasons and permit numbers have been adjusted to maintain hunter satisfaction. Memorable class deer are adequately available to stimulate non-resident hunters to make the state a destination.

Presenters: LLOYD FOX and MATT PEEK, Kansas Department of Wildlife

ABUNDANCE OF MULE DEER IN NORTHERN SONORA AND CHIHUAHUA, MÉXICO

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Abstract: The mule deer is the largest of the four species of deer in Mexico. Mule deer and white-tailed deer are the main prey for large carnivores, and both are highly regarded for their hunting value. There are a small number of mule deer studies in Mexico, with range reduction occurring due to habitat loss, it is necessary to have baseline data to develop management plans for the species. Our objective was to estimate the abundance of mule deer in the northern states of Sonora and Chihuahua, Mexico using



camera trap surveys. We placed camera traps in four ranches for a 30 day period. Mule deer were individually identified and built a capture-recapture history by site. The abundance was calculated using MARK, and density was obtained by dividing the abundance between the effective sampling area, based on published home range size. The lowest abundance and density were obtained in the Ojos Ranch, in Sonora (11 individuals; 0.14 ind./Km²). The site also include white-tailed deer (2.1 ind./Km²). On San Bernardino and Los Fresnos ranches, Sonora, was obtained an abundance of 70 and 32 mule-deer and a density of 1.56 and 0.6 ind./Km² respectively. In Chihuahua, in the foothills of the Sierra del Nido, the abundance was 42 individuals and density of 0.8 ind./Km². Our results indicate that higher abundance of mule deer occurs in lower elevations and relatively flat areas with scrubland and grassland vegetation. Continuous monitoring is necessary to assess the species current distribution and the number of deer that can be extracted through regulated hunting.

Presenter: CARLOS LÓPEZ-GONZÁLEZ

STATUS OF DEER AND ELK POPULATIONS IN MONTANA, 1960-2012

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Abstract: State-wide, elk numbers and harvest have shown an increasing trend since 1970, however we may have reached a peak in elk numbers, in the early 1990s when harvest exceeded 30,000 animals. Since 2007, in some hunting districts in the western part of the state, elk numbers are declining while in the eastern part of the state relatively “new” populations of elk continue to increase rapidly. Mule deer harvest and populations have shown a long-term decline since 1960. Peak harvests of male mule deer (>60,000) were achieved in the latter part of the 1960s, 1970s and 1980s. Between 1995 and 2007 harvest fell to around 40,000 males and in 2010 and 2011, near record low numbers of males were killed. Numbers and distribution of white-tailed deer has increased since 1960. In the 1960s less than 16,000 males were harvested annually and that number increased to nearly 30,000 for most of the 1990s, and the first 8 years of this century. Harvest indicates that the western part of the state has seen the largest increases in white-tailed deer since 1960 while the eastern part of the state has had a relatively stable population. Even though the long-term harvest trend indicates increases in populations, white-tailed deer harvest has declined on a state-wide basis since 2008. Sixteen of 162 hunting districts are managed for older aged mule deer bucks. Thirty-eight of 162 hunting districts allow elk hunting of males by special permit only and older aged males can be harvested on public and private lands in these areas.

Presenter: QUENTIN KUJALA, Montana Fish, Wildlife and Parks

STATUS OF DEER AND ELK POPULATIONS IN NEBRASKA

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Abstract: Nebraska's whitetail population peaked in July 2012 and was over objective in most units. Aggressive antlerless harvest (500,000 "free antlerless tags") was not successful in reducing herds in many areas as hunters tired of harvesting antlerless whitetails. The EHD event of 2012 likely killed 1/3 of the WT herd and reduced the population to about 200,000. Herds in several units will be allowed to increase in 2013. Mule deer populations are the lowest in 10 years (70,000), having peaked in 2008 at a record high (100,000). Mortality due to CWD, meningeal worm, drought, coyote predation, habitat loss and whitetail competition has reduced MD herds despite the lowest antlerless harvest in 30 years. Aggressive WT doe harvest and restricted MD doe harvest will continue in most mule deer units. Elk populations should exceed 3,000 in 2013. Herds occupy the western ½ of the state, with 80% in the panhandle. Seasons have been held since 1995. Annual herd growth exceeds 15%. Average age of harvested bulls exceeds 5 years and success on bull tags was above 79% the past 5 years. Landowner acceptance of elk remains high and herds continue to grow. Nonresident access to deer permits is restricted on about 5% of our deer permits. In all other units residents and nonresidents have equal access. Unlimited \$5 youth whitetail permits for residents and nonresidents under 16 are used to encourage youth hunting.

Presenter: KIT HAMS, Big Game Program Manager

CURRENT STATUS OF DEER AND ELK POPULATIONS IN NEVADA

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Abstract: Nevada currently has about 110,000 deer and 15,000 elk. Deer are slightly above the 10-year average and slightly below the 20 year average. Elk populations are relatively new in Nevada and have gone from 2,000 in 1990 to 15,000 in 2012. Helicopter surveys are used to assess population trend and size in Nevada. Deer surveys are done twice annually; fall and spring while elk surveys are done once in mid winter. Although no check stations are used in Nevada, a mandatory hunter questionnaire is utilized to determine harvest for both species. The two main factors affecting opportunity are herd population performance and politics. Deer rifle deer hunters have maintained a success of ~40% and statewide, hunters harvest about 45% 4 points or better. Elk harvest has experienced sharp increases, especially cow harvest. Rifle bull hunters enjoy a hunter success of around 65% with a statewide 6 point or better of 72%. Deer and elk harvest is measured as a percent of successful hunters by weapon class and total number of animals of each point class. Reporting is mandatory. For both deer and elk there is greater emphasis placed on trophy harvest than opportunity. However, for deer, Nevada has many areas using a split season strategy with short, hot, dry, relatively crowded hunts followed by long, cool, un-crowded hunts. Elk hunting is exclusively a trophy harvest management strategy. Deer quotas are primarily determined by post-hunt buck ratio objectives. Elk quotas are more flexible and are used to keep populations near objectives while still maintaining quality.

Presenter: TONY WASLEY, Nevada Department of Wildlife



STATUS OF DEER AND ELK IN NEW MEXICO, 1995-2011.

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Abstract: In New Mexico, mule deer population estimates decreased precipitously 1995–2003, increased slightly 2004–2009, and decreased slightly 2010–2011. Declines in mule deer population estimates followed changes to habitat conditions and protection of top predators. Conversely, white-tailed deer population estimates increased 1995–2011. Expansions of white-tailed deer populations followed brush encroachment and expansion of agriculture. Rocky Mountain elk population estimates increased to stabilization 1995–2011. Expanding elk populations resulted from changes in habitat conditions and conservative harvest management. Population estimation and monitoring techniques evolved from trend surveys to sightability models to population reconstruction. Mule deer harvest decreased following the population decline while public hunts transitioned from over-the-counter to draw-only. White-tailed deer harvest increased as populations expanded and additional opportunity was provided through white-tailed-deer-only hunts. Elk harvest increased slightly and then stabilized from 1995–2011 as statewide elk populations also stabilized. Harvest information became mandatory for deer and elk in 2006, greatly increasing the number of reports and reducing the amount of positive bias from voluntary reports. Deer harvest management shifted over the years from primarily unlimited opportunity through over-the-counter hunts to limited draw hunts of which approximately 25% were managed for quality based on male age structure and hunter numbers. Elk harvest management changed as social carrying capacity shifted from lesser to greater tolerance, while quality management encompassed approximately 40% of elk herds based on male age structure and hunter numbers. Managers continue to struggle with determining and trying to reverse the ultimate causes of the mule deer decline, and providing as much hunter opportunity as possible while maintaining some trophy quality.

Presenter: STEWART LILEY, New Mexico Department of Game and Fish

STATUS OF DEER AND ELK POPULATIONS IN OREGON

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Abstract: In total Rocky Mountain elk populations are basically stable below objective levels. However, some regional populations are higher than desired. Roosevelt elk are stable in the Coast range areas but depressed in the Cascade Range, and are well below management objectives. Mule deer also are basically stable with a few areas showing some increases. Black-tailed deer continue to be depressed



throughout most of their range in Oregon. Columbian white-tailed deer are doing well in southwestern Oregon but remain endangered in northwestern Oregon. Oregon employs a combination of aerial trend count, aerial survey sampling, ground trend count, ground classification, and spotlight counts to monitor deer and elk populations. Hunting and harvest are down the last few years in Oregon compared to about 10 years ago. Through 2012 harvest has been measured with random telephone harvest surveys. In 2010, a mandatory survey reporting system was implemented. However, response rates were too low to be usable until a penalty was assessed beginning for the 2012-2013 hunting seasons. Oregon's primary management is to provide hunter opportunity. Roosevelt elk, Rocky Mountain elk, and Mule deer are guided by specific management objectives for populations and male:female ratios. Black-tailed deer management is guided by benchmark measures for harvest success, buck ratios, and population trend indices. Management itself has not necessarily changed dramatically; no changes to season frameworks, timing, etc. The number of controlled tags offered has declined slightly in recent years, primarily in response to declines in Roosevelt and black-tailed deer populations. The biggest issues Oregon faces are related to lack of timber harvest in western Oregon, and associated changes to habitat capabilities.

Presenter: DON WHITTAKER, Oregon Department of Fish and Wildlife

STATUS OF DEER AND ELK POPULATIONS IN SOUTH DAKOTA, 2002-2011

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Abstract: Over the last 10 years deer and elk populations in South Dakota have reached record highs followed by precipitous declines. South Dakota is approximately 80% private land, thus landowner tolerances of wildlife influence population objectives. In the mid-2000s populations of both deer and elk exceeded landowner tolerances, and harvest regulations were liberalized to reduce populations. Beginning in the winter 2008/09, South Dakota experienced 3 consecutive severe winters, each followed by increased observations of winter mortality and decreased recruitment of deer. Deer mortalities from hemorrhagic disease were also documented at record levels in the summer/fall of 2011 and 2012. Further, in the mid-2000s the mountain lion population in the Black Hills expanded to relatively high densities and preliminary research on elk suggests unsustainable levels of calf predation in some management units. Record harvest levels, severe winters, disease, and predation all contributed to deer and elk population declines. Accustomed to high densities of big game populations and abundant harvest opportunities, publics were dissatisfied with reduced deer and elk abundance and successfully applied political pressure that resulted in a formal outside review of big game management by the Division of Wildlife. Big game populations are beginning to recover in some areas of South Dakota, although future weather conditions, predation, the unknowns of future energy development, and habitat loss in the form of native prairie conversion rates not seen since the Great Depression, loss of wetlands and shelterbelts, and loss of Conservation Reserve Program lands (~450,000 acres lost from 2006-11) will likely complicate recovery and impact social tolerances.

Presenter: ANDY LINDBLOOM, South Dakota Department of Game, Fish, and Parks



STATUS OF DEER AND ELK POPULATIONS IN TEXAS, 2005-2011

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Abstract: In 2004, Texas Parks and Wildlife Department (TPWD) went through a comprehensive science review of the Department's survey methodologies by the Wildlife Management Institute (WMI). This critical review recommended TPWD to improve survey techniques for deer. Therefore, TPWD revamped survey methodologies for both mule and white-tailed deer based upon recommendations from WMI. These changes were implemented during the 2005 survey season. In addition, TPWD recently conducted research to develop a mule deer sightability model to improve population estimates. The mule deer sightability model was initiated in 2011. Currently, TPWD conducts post-season helicopter surveys for mule deer utilizing a stratified random sampling design within monitoring units. TPWD also uses a non-linear line-transect spotlight survey method (Distance Sampling) to survey and estimate white-tailed deer populations. The data are used to determine population trends, estimate population densities, and document herd composition to evaluate the impacts of regulations and management actions on deer at an ecoregion and management unit scale. Since 2005, mule deer numbers have been stable to increasing in the Panhandle ecoregion with approximately 82,000 mule deer estimated in 2011. In contrast, mule deer estimates are trending downward for the Trans-Pecos ecoregion and in 2011 mule deer numbers were estimated at about 140,000. Texas' white-tailed deer herd has been stable over the last 7 years and was estimated at 3.3 million in 2011. Statewide deer harvest data is obtained by a questionnaire mailed to a random sample of 25,000 hunting license purchasers annually. In general, deer harvest mirrors population trends through time. Mule deer harvest was about 8,000 and white-tailed deer harvest was estimated at approximately 575,000 during the 2011 hunting season. The Texas Legislature designated elk as an exotic species in 1997. Since the 1997 reclassification as an exotic by the state legislature, the Texas Animal Health Commission has been responsible for managing elk, primarily for disease monitoring. Elk reside throughout most of Texas with large populations within game farms and high-fence ranches. Most free-ranging elk exist in west Texas. TPWD does not conduct annual elk surveys to determine population trends or harvest. There are no seasons or bag limits on elk in Texas; therefore, elk can be hunted/harvested 365 days a year with no annual or possession bag limits.

Presenter: SHAWN GRAY, Texas Parks and Wildlife Department

STATUS OF DEER AND ELK IN UTAH, 2000-2013

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Abstract: Utah's statewide deer population is stable, but lower than historical highs. We estimate the statewide population to be about 318,000. The population has been around 300,000 since the late 1990's with weather driven fluctuations. Utah's elk population has steadily grown from about 62,500 in 2000 to a current estimate of about 79,700. Deer populations are estimated using computer models. Natural mortality inputs to the model are estimated using survival rates of collared does and fawns on 7



representative units. Ground classification and harvest data are also used as input to the model. Elk populations are estimated using hybrid approach that includes helicopter survey flights every 3 years and modeling in the non-flight years. Harvest trends follow population trend with a stable trend for deer and an increasing trend for elk over the past 10 years. Harvest is estimated using a combination of phone and internet based surveys. We use a combination of random sample and mandatory reply surveys, depending on the hunt type. Utah tries to strike a balance between the demand for hunting opportunity and antler quality. For deer, we provide general season opportunity on the majority of the units and set aside a few units where we manage for large antlered animals. For elk we create opportunity by harvesting spike bulls on units that we also manage for large antlered animals on a limited entry basis. We also provide any bull elk hunting opportunity on units that have large areas of private land or wilderness. We base our buck deer permits on post season buck to doe ratios and our bull elk permits on average age of harvested bulls. Habitat quality and quantity continues to be the limiting factors for mule deer. Our elk populations are not limited by habitat since most of our population objectives are socially driven. Competition with livestock and aspen regeneration are the main issues that limit elk population objective increases.

Presenter: ANIS AOUBE, Utah Division of Wildlife Resources

MULE DEER MANAGEMENT IN WYOMING: THE PARADIGM OF A PUBLIC OWNED RESOURCE

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Abstract: Mule deer management in Wyoming is a changing landscape as mule deer populations continue to decline. Balancing society's expectations and desires with declining mule deer populations requires increased and meaningful public involvement. The Wyoming Game and Fish Department (WGFD) has undertaken a "Collaborative Learning" process to engage the public in two of Wyoming's premier mule deer herd units under the direction of the Wyoming Mule Deer Initiative. This process has resulted in increased public understanding and sustained involvement, increased agency understanding of the public's issues and concerns, the development of herd unit management plans, and in the Platte Valley the creation of a Habitat Partnership. The paradigm of increased public involvement involves agency risk and therefore was not initially widely accepted by field personnel. This process has created improved public relations and support through an environment that facilitated scientific delivery, increased social capacity and trust.

Presenter: DARYL W. LUTZ, Wyoming Game and Fish Department

STATUS OF DEER AND ELK POPULATIONS IN WYOMING, 1990-2013

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Abstract: Mule deer populations in Wyoming declined the last two decades from ~540,000 in 1990 to ~375,000 deer in 2011. Elk populations continue to increase (~82,000 in 1990 to ~110,000 in 2011). Some mule deer populations, in more mesic portions of Wyoming, have been buffered. Elk in the northwest where low pregnancy rates in combination with predation and other variables are measurably impacting elk calf production/survival are the exception. Harvest data (collected voluntarily via a paper/internet survey), post-season sex and age composition data, and limited survival data are used in spreadsheet models to estimate population size/trend. In some elk herds mid-winter trend data is used rather than model estimates. Data are collected primarily from helicopter after the hunting season or mid-winter. Mule deer harvest has declined sharply. Elk harvest is relatively stable. Deer and elk management is directed using a “management by objective” strategy and a designation of “recreational”, “special” or private land herd unit. The “special” designation is akin to “trophy” management to maintain high male/female ratios. Wyoming has undertaken a massive public involvement process under the Wyoming Mule Deer Initiative to engage everyone interested in mule deer in a MEANINGFUL way. Primary issues: Mule Deer – 1) Declining populations driven by poor fawn production/survival and 2) Related socio/political aspects of reduced deer hunting opportunity and declining hunt quality. Elk – 1) Increasing populations exceeding landowner tolerance leading to more and larger damage claims and calls for political solutions, and 2) Inability to manage towards population objectives utilizing hunter harvest in some herds.

Presenter: Will Schultz, Wyoming Game and Fish Department

Abstracts – Paper Presentations, 2013

Alphabetical by Senior Author



THEORETICAL ELK HABITAT CHANGE IN RESPONSE TO PRESCRIBED BURNING IN WEST-CENTRAL ALBERTA

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Abstract: In 2005, a stakeholder input process was undertaken to establish the values and objectives for a prescribed-burn-focused forest management plan for Alberta's Bighorn Backcountry. Representatives of the hunting community expressed their desire for future prescribed burns to maintain or improve the value of ungulate winter and summer habitat. Using a GIS-based habitat disturbance planning tool, developed in collaboration with the University of Alberta and Alberta Sustainable Resource Development, we assessed a series of options for prescribed burn planning in terms of the expected impact on elk summer and winter habitat. Following the completion of a 5,700 ha burn, we re-evaluated the theoretical elk habitat value using the tool and found that the prescribed burn produced an increase in safe (source) habitat that surpassed the predicted values based on the proposed burn unit boundary. The amount of summer habitat within the watershed increased most significantly in area of risky (sink) habitat; however, the patches of source habitat did become larger and more continuous. The models suggested that winter source habitat increased by roughly 30%, as opposed to the initially-predicted 20%, while winter sink habitat increased by 4%. We discuss these results, their limitations, and the need to assess this theoretical habitat change with ground-based monitoring.

Presenter: ROBERT B. ANDERSON, Alberta Conservation Association

UNDERSTANDING AND MANAGING ELK DECLINE IN JASPER NATIONAL PARK

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Abstract: Identifying the ecological factors driving population distribution is an interest to wildlife managers in order to determine the actions needed for a particular outcome. In the Canadian Rocky Mountains, elk (*Cervus elaphus*) are an ubiquitous mega fauna esteemed for sport hunting, wildlife viewing opportunities and conservation value. Since the introduction of elk in Jasper National Park, Alberta in 1920 populations have fluctuated over time due to predation, food availability and climate, yet from the mid 1990s Parks Canada has observed a steady population decline. This study examines the mechanisms of decline of elk in Jasper National Park. More specifically, it incorporates wolf and elk telemetry data with existing biophysical data. Akaike Information Criteria will be used to construct generalized linear models to explain the resources that are critical to elk. Spatial patterns of resource selection by elk are proven to depend upon wolf predation risk, human activity, and other habitat characteristics. This approach allows for the disentanglement of top-down (predator and human driven) and bottom-up (food or resource-limited) processes and the examination of the specific causes of decline. Additionally, data from a multi-year vegetation management program are used to assess what habitat characteristics can and are being modified to increase elk populations, which will be presented. The presence of elk populations can have ecological, social and economic benefits and can cause conflicts with humans. By unravelling the relative roles of different ecological forces in determining population change, this study will contribute to managing and conserving sustainable elk populations in Jasper and other National Parks.

Presenter: COLLEEN ARNISON, Masters Candidate, University of Calgary

A PARADIGM SHIFT FOR MITIGATION ON PUBLIC LANDS – LANDSCAPE MITIGATION, MITIGATION BANKING, AND CONSERVATION CREDITS: WILL MULE DEER AND ELK BENEFIT?

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Abstract: In an attempt address a boom in industrial energy development, the Department of Interior has proposed changing the way energy projects are mitigated from an on-site basis to one that works within the landscape perspective. The Final Programmatic Environmental Impact Statement and Record of Decision for Solar Energy Development for the SW US put into policy the use of “Regional Mitigation Plans” to offset the impacts from industrial solar development in the 17 identified Solar Energy Zones. This action has led to a potential paradigm shift about how mitigation can be more effective in dealing with energy development including wind, oil shale, shale gas, and traditional oil and gas development. Key components of what constitutes landscape mitigation are being developed and some organizations are promoting mitigation banking and the establishment of conservation credit trading systems. Traditional approaches to mitigation banking and conservation credits have focused on wetlands and species protected under the Endangered Species Act. Biodiversity is also being contemplated as the metric to base mitigation “credits.” The Mule Deer Foundation, TRCP and other organizations are working to ensure that mule deer and other big game species, which are common and hunted, are not overlooked as important in the development of these approaches. The challenge will be to make sure that habitat and population management and current scientific knowledge is incorporated into these approaches so that healthy and sustainable populations of big game are a result of this approach and are not sacrificed to the needs of other species.

Presenter: STEVEN R. BELINDA, Beartooth Strategies, LLC



EFFECT OF HABITAT MANAGEMENT ON OVERWINTER SURVIVAL OF MULE DEER FAWNS IN COLORADO

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Abstract: Wildlife managers are often compelled to identify the primary limiting factor to population growth in populations. Due to their iconic status, mule deer (*Odocoileus hemionus*) exemplify this need. Habitat management, in the form of mechanical or chemical manipulation of the vegetative landscape, has been utilized as a population management strategy to bolster mule deer populations. Yet evaluation of this strategy in the form of deer population response has been lacking. To address a knowledge gap and to evaluate the effectiveness of habitat management as a deer population management strategy, we conducted a 4-year study that measured the overwinter survival of mule deer fawns on study units that had experienced different levels of habitat management efforts. When partitioned into different levels of treatment intensity, mule deer fawns inhabiting winter range that received both traditional treatments and follow-up treatments experienced higher survival ($\hat{S} = 0.768$, $SE = 0.0849$) than fawns on units that experienced only traditional treatments ($\hat{S} = 0.687$, $SE = 0.108$), which in turn experienced higher survival than fawns in areas that had received no habitat treatments ($\hat{S} = 0.669$, $SE = 0.113$). When study unit differences in overwinter fawn survival were incorporated into a population matrix model, finite population growth rates increased from 1.098 to 1.151 in study units that had received multiple habitat treatments. Our study provides evidence supporting the long-held view that habitat management is a viable population management strategy for mule deer in pinyon pine (*Pinyon edulis*) - Utah juniper (*Juniperus osteosperma*) ecosystems.

Presenter: ERIC J. BERGMAN, Colorado Parks and Wildlife

CAUSE-SPECIFIC MORTALITY AND SURVIVAL RATES OF NEONATAL ELK (*CERVUS ELAPHUS*) ON THE VALLES CALDERA NATIONAL PRESERVE, NEW MEXICO

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Abstract: For the past decade, low calf:cow ratios of elk (*Cervus elaphus*) have been recorded on the Valles Caldera National Preserve (VCNP) in northern New Mexico. In this study, we addressed the hypothesis that the observed low calf:cow ratios on the VCNP may be the result of unusually high calf mortality rates. We radio marked elk calves ($n = 140$) born within the VCNP from 2009-2011 to determine cause-specific mortality and used known fate models in Program MARK to estimate survival. We used biological covariates to model survival for 14 days post capture and weekly summer survival ($t = 13$ weeks). Predation accounted for 94.8% of the known deaths. Black bears (*Ursus americanus*) were the highest source of predation (47.3%, $n = 26$) and overall mortality (40.6%). Coyotes (*Canis latrans*) were the second highest source of predation (41.8%, $n = 23$) and overall mortality (35.9%). Age at capture was the best biological covariate at predicting survival. Fourteen day survival was 0.57 (SE = 0.05, 95%CI: 0.48-0.66), summer survival was estimated to be 0.37 (SE = 0.05, 95%CI 0.28-0.47). Our results are comparable to other studies which investigated low calf:cow ratios. Therefore the predation of elk calves is likely additive and causing suppressed recruitment rates in the elk population on the VCNP. However, we highly recommend a population estimate of the large predators prior to any large predator management action to ensure populations of large predators are not reduced to a level from which they cannot recover.

Presenter: LANCE J. BERNAL, Department of Natural Resources, Texas Tech University

IMPACTS OF MINING ON MULE DEER MIGRATIONS IN NEVADA

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Abstract: Over the past century, mule deer (*Odocoileus hemionus*) have suffered dramatic declines throughout the western United States due, in part, to loss of wintering habitat and migratory corridors. An increase in mineral exploration across Nevada has raised the level of concern over the protection of ungulate migration routes throughout the state. In January of 2012, the Nevada Department of Wildlife (NDOW) and University of Nevada, Reno (UNR) captured and applied radio collars to 12 female mule deer in the proximity of an active mine in the Ruby Mountains of eastern Nevada. Collars were scheduled to collect locations at 1 hour intervals during migrations to give an accurate depiction of migratory behavior in and away from mining facilities. We used Brownian Bridge Movement Models (BBMM) to delineate stopover sites for each individual during both the fall and spring migration periods. We calculated route efficiency and movement rate between stopover locations and throughout the mining area to determine the effects of the mine on movement patterns during migration. We hypothesized that mule deer would show higher route efficiency and movement rates between stopovers than through the mining complex. Mule deer showed an increase in route efficiency and movement rate between stopover locations when compared with movement through the mining facilities. These results suggest an increase in energy expenditures of mule deer forced to navigate these mining complexes, which may negatively impact migratory behavior.

Presenter: MARCUS E. BLUM, Natural Resources and Environmental Science, University of Nevada Reno

2012 IDAHO ELK HUNTER OPINIONS AND ATTITUDE SURVEY

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Abstract: A statewide random survey of Idaho's elk hunters was contracted to the University of Idaho's Department of Conservation Social Sciences from the College of Natural Resources in early 2012. The random survey was mailed to 6,200 hunters who purchased a general Idaho elk tag in 2011; over 2,786 elk hunters responded to the survey. The objective of the survey was to measure current hunter demographics, elk hunting preferences and motivations, and attributes of a quality elk hunting experience. This study was the first comprehensive investigation of Idaho elk hunters since a similar study was conducted by the University of Idaho over 20 years ago in 1987. Results from the survey indicate that what is important to Idaho elk hunters is the opportunity to hunt elk every year, to hunt with family and friends, to see a harvestable elk, and to hunt for mature bulls. Further, we were able to compare some questions from the 2012 survey with the 1987 survey. The median age of elk hunters today is 50 years compared to 40 years in 1989. In 2012, 77% of survey respondents said they would miss Idaho elk hunting a great deal if they could not participate, compared to just 54% in 1987. In 2012, 43% of the people surveyed said it was extremely important to hunt elk with family, compared to just 28% in 1987. The results of the 2012 survey are being used by the Idaho Department of Fish and Game to revise its Elk Management Plan.

Presenter: CRAIG WHITE, Idaho Department of Fish and Game

TRADE-OFFS BETWEEN PREDATION RISK AND FOOD QUALITY RE-DISTRIBUTE ELK ACROSS A ROAD NETWORK: NOT ALL ROADS ARE EQUAL

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Abstract: Roads do not have universal effects on behaviour of wildlife: differences in the response of elk to roads could depend on trade-offs between predation risk and food quality. The study occurred in SW Alberta-Canada, and encompassed three different land types: protected areas, public and private lands. We quantified perception of humans as a predator by elk (vigilance data), distribution of food quality (NDVI), and we showed that natural predators were more abundant far from roads (camera data). We combined satellite telemetry data with a unique dataset on traffic volumes to predict selection for roads by elk (n=128) using RSFs. In the national park humans were scarcely perceived as a risk by elk, and



vegetation quality was higher far from roads. Male elk selected best feeding areas far from roads. Females showed high selection for roads implying that they traded high-quality vegetation for security provided by humans. Humans on public and private lands were perceived as a risk by elk (hunting permitted), and both sexes showed strong avoidance of roads during the day. High quality vegetation was widespread on private lands, but was more abundant close to roads in public lands. Elk exploited areas with low vegetation quality during the day in public lands: they compensated for this at night by increasing selection for roads with low traffic volumes. Perception of humans as predators, the presence of natural predators, and distribution of food appear to be the main drivers that must be considered to anticipate the effect of roads on wildlife.

Presenter: SIMONE CIUTI, Dept. of Biological Sciences, University of Alberta

ELK CONTACT PATTERNS AND POTENTIAL DISEASE TRANSMISSION

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Abstract: Understanding the drivers of contact rates among individuals is critical to understanding disease dynamics and implementing targeted control measures. We studied the interaction patterns of 149 female elk (*Cervus elaphus*) distributed across five different regions of western Wyoming over three years, defining a contact as an approach within one body length (~2m). Using hierarchical models that account for correlations within individuals, pairs and groups, we found that pairwise contact rates within a group declined by a factor of three as group sizes increased 30-fold. Meanwhile, per capita contact



rates increased with group size due to the increasing number of potential pairs. The increase, however, was non-linear and not as strong as would be expected for a purely density-dependent model of disease transmission. We found similar patterns for the duration of contacts. Supplemental feeding of elk had a limited impact on pairwise interaction rates and durations, but increased per capita rates more than two times higher. Variation in contact patterns were driven more by environmental factors such as group size than either individual or pairwise differences. Female elk in this region fall between the expectation of contact rates that linearly increase with group size (as assumed by pseudo-mass action models of disease transmission) or are constant with changes in group size (as assumed by frequency dependent transmission models). Our statistical approach decomposes the variation in contact rate into individual, dyadic, and environmental effects, which provides insight those factors that are important for effective disease control programs.

Presenter: PAUL C. CROSS, U.S. Geological Survey, Northern Rocky Mountain Science Center

BOTTOM-UP AND TOP-DOWN EFFECTS ON NORTHERN YELLOWSTONE ELK PREGNANCY AND RECRUITMENT RATES

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Abstract: Declines in calf recruitment in some western Montana elk populations have raised concerns that recovering carnivore populations may be limiting elk population growth. However, a suite of bottom-up and top-down factors likely affect recruitment, and better understanding the relative effects of these factors on pregnancy rates and calf survival is needed to determine appropriate management responses to poor recruitment. We conducted a retrospective analysis to evaluate the effects of wolf (*Canis lupus*) and grizzly bear (*Ursus arctos*) numbers, winter severity and summertime drought on northern Yellowstone elk yearling pregnancy rates, adult pregnancy rates, juvenile-at-heel in late autumn, and recruitment using data collected during 1985-2007. We found no influence of any covariate on adult pregnancy rates, that drought and grizzly numbers influenced calf survival between birth and late autumn, and that wolf numbers and winter severity influenced juvenile survival through winter. The results provide context to how predation and density-independent variables affect elk recruitment through the year.

Presenter: JULIE CUNNINGHAM, Biologist, Montana Fish, Wildlife and Parks

GEO-STATISTICAL METHODS FOR DETECTING ELK PARTURITION SITES FROM GLOBAL POSITIONING SYSTEM COLLAR DATA

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Abstract: There is an increasing awareness of the importance of juvenile survival in ungulate population dynamics and the accurate prediction of parturition timing and location may help in understanding the role of birth site selection on neonate survival. Detecting birth sites in a statistically rigorous way, however, often requires intensive field efforts that may not be possible for all studies. We developed a method for detecting parturition timing and location based on daily movements and space-use metrics derived from GPS collar locational data from 67 elk which were simultaneously fitted with Vaginal Implant Transmitters (VITs). Assuming the timing and location of VIT expulsion represented parturition, we used logistic regression and cross validation (10 fold; 10 replications) to assess the temporal and spatial prediction accuracy of different candidate models. Our top model predicted the correct parturition date (MSE=0) for 73% (+/- 3) of the test elk (n=67), and 83% (+/-2) of prediction dates fell within 3 days of the VIT date. Of the remaining elk that were poorly estimated, roughly elk (~80%) selected a date ≤ 3 days of the VIT parturition date as the second most likely parturition date. When the day was correctly predicted spatial errors between the VIT and the predicted location were extremely low (median = 9.9 m +/- 0.4 m). When including all elk with prediction errors ≤ 3 days, the median error was still <100 m. We discuss the application of our results to current and future elk research related to parturition ecology.

Presenter: MIKE EBINGER, Institute on Ecosystems, Montana State University

THE COLLAPSE OF THE BURDETTE CREEK ELK HERD IN WESTERN MONTANA.

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Abstract: A century since the first reintroductions of Rocky Mountain elk (*Cervus elaphus*) from Yellowstone National Park, Montana and Idaho are re-experiencing near extirpations of backcountry elk populations in portions of the Bitterroot Range, including the Burdette Creek elk herd. Hypotheses of environmental stochasticity, declining habitat quality, and overharvest do not adequately explain these declines. The declines in the Burdette Creek elk population are reflective of similar population trends of intensively studied elk in the Kelly Creek and Cayuse survey units in adjacent Game Management Unit (GMU) 10 in Idaho, a known seasonal range for portions of the Burdette Creek elk herd and other elk in the Fish Creek drainage. Since 1996, Idaho Fish and Game personnel have conducted extensive research on elk population dynamics in GMU 10 and elsewhere. In these areas, elk numbers show no sign of stabilizing at lowered, sustainable levels in the face of recovered predation pressure. With the documented connectivity between GMU 10 and the Fish Creek drainage, we compare the Burdette Creek elk herd in Montana with Kelly Creek and Cayuse elk populations and research results from Idaho. If elk are to persist in numbers supporting predation by the historic suite of large carnivores and a moderated level of recreational hunting, wildlife managers must be aware that the traditional view of elk populations rebounding will not serve in recovered predator-prey systems. In addition, management response to subtle indicators of calf recruitment declines must be prompt and substantive to continue to maintain sustainable elk populations.

Presenter: VICTORIA EDWARDS, Montana Fish Wildlife and Parks

MANAGING THE NORTH HILLS/EVARO ELK HERD IN THE WILDLAND-URBAN INTERFACE OF MISSOULA, MT—ADAPTIVE MANAGEMENT RESPONSES TO SHIFTING ELK DISTRIBUTION AND BEHAVIOR

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Abstract: Wildlife biologists with Montana Fish, Wildlife and Parks have worked cooperatively with private landowners, non-governmental organizations, and federal and local governments to conserve important elk winter range and habitat connectivity within the wildland-urban interface of the Missoula Valley in western Montana. From a biological perspective, we have been extremely successful in managing for the persistence of elk populations. However, protecting winter range adjacent to and fragmented by human development has additional management challenges and costs, including limited hunter access and opportunity. Since 1982, the North Hills/Evaro elk herd in the Missoula Valley has grown an average of 10% annually, with the greatest increase occurring between 2000 and 2007 from 188 to 398 elk observed. From 2007 to 2012, elk abundance has been high but relatively stable, with the most recent count at 454—well above the population objective of 300. Without effective harvest, the population is expected to double in 7-years. In the last 2-years, we have observed an increase in the



number of elk becoming more resident and more visible throughout the year on their winter range. While portions of the herd remain migratory, they continue to migrate to their winter range earlier and leave later in the spring. To continue to keep elk wild, managers must reassess current management of the North Hills/Evaro elk herd. This presentation includes a discussion on the adaptive management approaches utilized by wildlife managers, the efficacy of those strategies, and potential “outside-the-box” opportunities to improve elk management in the wildland-urban interface.

Presenter: VICTORIA EDWARDS, Montana Fish, Wildlife and Parks

SHOULD I STAY OR SHOULD I GO? VARIATION IN MIGRATORY BEHAVIOR BALANCES FITNESS IN A PARTIALLY MIGRATORY ELK POPULATION

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Abstract: Within migratory species, individuals that migrate are expected to enhance lifetime fitness through exposure to higher quality forage and avoidance of predation to a greater degree than non-migratory conspecifics. Partially migratory populations, with migratory and non-migratory individuals, are expected to be maintained by balancing fitness between migrant and non-migrant phenotypes. However, recent studies acknowledge variability in migratory behavior that occurs along a gradient between migratory and non-migratory strategies. We tested for variability in migratory behavior in a partially migratory elk (*Cervus elaphus*) population near Banff National Park, in Alberta, Canada. We used net squared displacement (NSD) from 223 radio-collared elk over a 10 year period measured from the winter range and plotted over time in combination with spatial displays in a Geographic Information System (GIS) to quantify annual movements. Second, we used Kaplan-Meier estimates of survival for 104 adult female mortalities combined with estimates of calf survival using a sight-resight design and pregnancy rates to build a population matrix model for calculating lambda of migrants and non-migrants. We found 15% of elk switched annually between migrant and non-migrant strategies as a density dependent response, where at high winter densities elk switched from non-migrant to migrant, and reversed that pattern at lower elk densities. We found little differences in adult female survival and lambda for migrant and non-migrant strategies across the entire study period. Our conclusion is that elk within this population make real-time changes in migratory strategies that balance fitness between non-migrant and migratory elk.

Presenter: SCOTT EGGEMAN, Wildlife Biology Program, University of Montana



EFFECTS OF MALE-BIASED HARVEST ON MULE DEER: IMPLICATIONS FOR RATES OF PREGNANCY AND SYNCHRONY/TIMING OF PARTURITION

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Abstract: Mule deer (*Odocoileus hemionus*) are an iconic western species, but most populations have declined over the past several decades. Evaluating how management practices influence population dynamics will enhance conservation of this species. For example, changes in sex ratio due to male-biased harvest alter rates of pregnancy, synchrony of parturition, and timing of parturition if inadequate numbers of males are present to breed females during their first estrous cycle. If rates of pregnancy or parturition are influenced by decreased buck:doe ratios, recruitment may be reduced (e.g., fewer births, later parturition resulting in lower survival of fawns, and a less synchronous parturition that potentially increases predation of neonates). Our objectives were to compare rates of pregnancy, synchrony of parturition, and timing of parturition between mule deer populations with a relatively high (Piceance Basin, CO; 28 bucks per 100 does) and a relatively low (Monroe Mountain, UT; 14 bucks per 100 does) sex ratio. We determined pregnancy rates via ultrasonography and synchrony/timing of parturition via vaginal implant transmitters. We found no differences in rates of pregnancy (98.6% and 96.6%; $p = 0.437$) or synchrony of parturition ($CV = 3.7\%$ and 4.8% ; $p = 0.282$) between Monroe Mountain and Piceance Basin, respectively. The low buck:doe ratio of Monroe Mountain were not associated with a protracted period of parturition suggesting that low buck:doe ratios typical of exploited populations do not influence population dynamics via rates of pregnancy or via synchrony/timing of parturition.

Presenter: ERIC D. FREEMAN, Brigham Young University

EVALUATION OF AN ANIMAL ACTIVATED ELK CROSSWALK AND HIGHWAY FENCING RETROFIT TO REDUCE ELK-VEHICLE COLLISIONS IN ARIZONA, USA.

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Abstract: Ideally, wildlife crossings are the best available solution to reduce ungulate-vehicle collisions while maintaining habitat connectivity. However, in many cases, innovative solutions need to be considered in order to address wildlife-vehicle collisions in a timely, cost-efficient manner. From 2007 to 2012, Arizona Game and Fish Department (AGFD) evaluated the effectiveness of a 4 km retrofit of existing right-of-way highway fencing designed to funnel animals to bridges and a “crosswalk” intended to reduce incidence of elk-vehicle collisions. The crosswalk was equipped an animal detection system identify wildlife and activate signs to alert motorists. We determined location of the crosswalk and fencing with GPS. Overall, we documented a 97% reduction in collisions with elk. Elk permeability decreased 70%. Motorist reduced their speeds 14 kilometres/hr and 68% of motorists braked when the signs were activated versus only 8% when the signs were off. The crosswalk system performed properly during 93% of test visits (n = 275) and video surveillance documented activation of signs when wildlife were present 98% of the time. Overall, increased traffic volumes reduced probability elk crossing the highway at the crosswalk. Following extensive monitoring we determined the installation an electrified wildlife guard (ElectraMat) was essential to keep animals from entering the right of way on the road surface and evaluation of its effectiveness is ongoing. Innovative solutions like these represent viable options to reduce wildlife-vehicle collisions, while allowing large ungulates, like elk, to access essential resources.

Presenter: JEFFREY W. GAGNON, Arizona Game and Fish Department

UNGULATE ACTIVITY CLASSIFICATION: CALIBRATING DUAL-AXIS ACTIVITY MONITOR GPS COLLARS FOR ROCKY MOUNTAIN ELK AND MULE DEER

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Abstract: Direct observation of free ranging ungulates is prohibitively difficult, making their behavior difficult to study. Collars equipped with motion-sensitive activity monitors provide a means to monitor



animal behavior remotely. Differences in motion among species necessitate species specific calibration models. To date, no calibrations have been conducted for Lotek 4400 GPS collars featuring dual-axis activity monitors for Rocky Mountain elk (*Cervus elaphus nelsoni*) or mule deer (*Odocoileus hemionus*). Calibration consisted of pairing detailed behavioral observations of captive collared animals with collar data over a programmed sampling interval to determine what activities were associated with what activity monitor values. During this process we discovered several sources of time-keeping error that can result in mismatches between behavior observations and collar data. We developed a correction technique which allowed us to improve average classification rates up to 61.7%. We then built and compared a series of models for each species featuring different behavior groupings using discriminant function analysis. Models were constructed using (pure) intervals containing only a single behavior and compared to models constructed using all (mixed) intervals. Classification models that used only pure intervals resulted in misclassification rates of up to 40% for some behaviors. Final mixed interval models allow classification of up to 4 behavior categories for elk and 3 for deer with >70% accuracy. Our calibration models will be made available on-line, allowing managers and researchers to interpret collar data for use in ongoing and future studies of ungulate ecology and management.

Presenter: ADAM GAYLORD, Oregon State University, Department of Fisheries and Wildlife

FORAGE DYNAMICS RELATED TO CHANGING FOREST PRACTICES AT MOUNT ST. HELENS, WASHINGTON

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Abstract: In the Pacific Northwest use of silvicultural herbicides to suppress vegetation that competes with tree seedlings may alter forage resources and contribute to low body fat levels of elk (*Cervus elaphus*) in some populations. We explore his hypothesis in a nutritionally explicit context for elk. We used a paired, retrospective vegetation sampling design to assess the influence of herbicides and herbivory on early (<13 yrs) seral forage availability in forests around Mount St. Helens. We found herbicides initially reduced total biomass and the proportion of plants shown to be selected or eaten randomly by elk ("Accepted" forages) and available digestible energy (DE), but for only two years after planting seedlings. Between 10-13 years, total forage and plants not selected by elk ("Avoided" forages) continued to increase in untreated sites, but on treated sites. At exclosures, total and accepted biomass was more abundant inside exclosures after 3 years related to shrub abundance and this translated into



lower availability of DE to ungulates outside exclosures after the first two years. Our results provide a basis for quantifying changing nutritional resources under different timber harvest alternatives on private and public lands in the Mount St. Helens area for relating habitat conditions to elk population numbers.

Presenter: EVELYN H. MERRILL, Department of Biological Sciences, University of Alberta

POPULATION DYNAMICS OF A FOREST UNGULATE RESPOND TO WINTER SEVERITY AND HABITAT ALTERATION

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Abstract: Changes to habitat and climate have become ubiquitous and can strongly influence wildlife population dynamics, including species of high ecological and economic importance such as ungulates. These effects often impact vital rates differentially, as certain life history processes are more vulnerable than others. We examine the effect of timber harvest and variable winter weather on a long-lived vertebrate, deer in the coastal temperate rainforest of Southeast Alaska. Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) are the dominant herbivore, and a key resource for subsistence hunters. Timber harvest plans for the Tongass National Forest incorporate deer density into management goals, but exclude environmental variability from calculations. We derived vital rates from life history data for 63 adult and 154 juveniles, and population growth rates from matrix-based life table response experiments. Timber-harvested areas produced a lower population growth rate than unharvested areas ($\lambda = 1.06$ and 1.12), explained primarily by variability in adult female fecundity and juvenile survival. Winter severity had a larger effect, with population growth rates ranging from 1.19 to 0.84, driven primarily by variability in juvenile survival. Climate models predict increasing winter precipitation and stochasticity, which along with continuing timber harvest may reduce future deer populations. Timber managers calculate deer carrying capacity using average winter severity. Instead, such plans should incorporate and monitor changing climate in an adaptive-management framework to ensure sustainable deer populations.

Presenter: SOPHIE GILBERT, Institute of Arctic Biology, University of Alaska Fairbanks



ELK HABITAT USE ON DEGRADED RANGELAND IN THE SAPPHIRE MOUNTAINS, MT

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Abstract: We monitored winter range use by elk in the Northern Sapphire Mountains of the Bitterroot Valley, Montana over the winters of 2011-2012 and 2012-13. The goal of the project is to acquire data on elk habitat use and grazing preference on a former cattle ranch. A herd of around 300 spends most of the winter on or near the study site. The highest wintering elk numbers were recorded in November 2011, with 426. Vegetation surveys were conducted on a grid pattern across the property during 2010 – 2012. Of the 3,845 hectares within the property boundary, 2,130 hectares of rangeland include altered plant communities due to intensive grazing, exotic forage grass seeding, and herbicide applications. Cheatgrass (*Bromus tectorum*) dominates 32% of the rangeland area. Seeded exotic forage grasses dominate 20% and perennial invaders dominate 6.8%. Pristine or less-degraded plant communities dominated by native grasses cover 681 hectares. We collected additional data for this project through observation, scat density surveys, diet analysis, and forage availability estimates through biomass collection. By March 2013, we conducted over 150 elk survey days with more than 450 spatially precise locations between two field seasons. Elk locations and frequency of observation were assessed using habitat selectors that include dominant vegetation, slope, aspect, elevation, and insolation. Preliminary analyses of the data gathered to date will provide insights in assessing elk response to restoration efforts that seek to replace many weed-dominated communities with diverse native vegetation.

Presenter: TEAGAN HAYES, MPG Ranch

EVALUATING BOTTOM-UP AND TOP-DOWN EFFECTS ON ELK SURVIVAL AND RECRUITMENT IN THE BITTERROOT VALLEY: YEAR TWO UPDATE

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Abstract: Understanding the contribution of recruitment to population growth rate in ungulates is a fundamental challenge to wildlife managers attempting to integrate carnivore and ungulate management. Like much of western Montana, in the southern Bitterroot Valley, the decline of elk (*Cervus elaphus*) populations and calf recruitment occurred concurrently with wolf (*Canis lupus*)



recovery. However, a multitude of abiotic, bottom-up and top-down factors likely affect calf survival, and ultimately, these factors may even compete in their effects on population growth rate of elk. We studied cause-specific mortality of elk calves to understand the role of competing mortality risk on calf recruitment in the East Fork and West Fork of the Bitterroot Valley, Montana. A total of 66 and 76 neonatal elk calves were captured in spring 2011 and 2012, respectively, and an additional 31 and 29 six month olds in late November 2011 and 2012. We estimated Kaplan-Meier non-parametric survival rates, preliminary factors affecting calf survival using Cox-proportional hazards models, and estimated cause-specific mortality using cumulative incidence functions in a competing risks framework. Preliminary analyses for the first 20 months of the research surprisingly indicate mountain lions as the leading cause of mortality for elk calves during both summer and winter, and little evidence for compensatory mortality between wolves and lions in late winter calf mortality. We also evaluated the role of summer range nutritional resources on maternal body condition, lactation performance, and calf birth weights. Preliminary results from nutritional work demonstrate potential bottom-up differences that may influence resilience of elk populations to top-down predation. Our study fills a critical knowledge gap regarding the role of summer vs winter mortality in elk and the role of nutrition in first year survival. The study will complement previous studies on elk population dynamics and help wildlife managers integrate carnivore and ungulate management across western Montana following carnivore recovery.

Presenter: MARK HEBBLEWHITE, Wildlife Biology Program, University of Montana

DEVELOPMENT OF GENETIC MARKERS TO IDENTIFY COUES, CARMEN MOUNTAIN, AND OTHER WHITETAILS

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Abstract: The Coues white-tailed deer (*Odocoileus virginianus couesi*) is separated geographically from other subspecies for most of its range. This smaller subspecies is phenotypically different than other



whitetails in the United States, but blends into other small subspecies at the southern extent of its range in Mexico. The closely-related Carmen Mountains white-tailed deer (*O. v. carminis*) occurs between the Coues and the larger Texas subspecies to the east (*O. v. texanus*). We used a suite of 21 microsatellite markers to evaluate their usefulness in differentiating the southwestern subspecies from other North American whitetails. Using only 8 microsatellite markers we were able to differentiate Coues from most other whitetail subspecies, but there was some overlap with the related Carmen Mountains whitetail. To refine the Coues-Carmen separation, we increased the suite of markers to 16 and used more sophisticated analytical techniques. We achieved acceptable separation of Carmen and Coues whitetails, satisfying our objective of developing a test to separate Coues white-tailed deer from other types of whitetails north of the Tropic of Cancer. Also, in the course of this work, we included a few southwestern mule deer samples and they separate quite obviously from all whitetail. Interestingly, known whitetail X mule deer hybrids plot directly between clusters of mule deer and whitetail, resulting in an easy way to test for very recent hybridization (at least F_1) using even old skin, bone, or antler shavings.

Presenter: JAMES R. HEFFELFINGER, Arizona Game and Fish Department

DEVELOPMENT OF A STANDARDIZED SURVEY PROTOCOL FOR MULE DEER HERDS THAT WINTER IN THE COLUMBIA PLATEAU ECOREGION

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Abstract: Washington Department of Fish and Wildlife (WDFW) manages mule deer (*Odocoileus hemionus*) populations throughout eastern Washington. However, for mule deer populations that winter in the Columbia Plateau Ecoregion (CPE), variation in survey methodology among management districts resulted in data that were weakly linked to management objectives limiting management inferences. Therefore, our primary goal was to develop a standardized survey protocol that would



generate unbiased and precise estimates of post-hunt population size, sex ratios, and age ratios across CPE management districts. To achieve that goal we employed a stratified random sample design and applied the Idaho mule deer sightability model. The number of mule deer wintering in the portion of the CPE we sampled in 2009, 2010, & 2011 was estimated to be 12,603 (90% C.I. \pm 3,185), 11,977 (90% C.I. \pm 1,818), and 13,589 (90% C.I. \pm 2,199), respectively. Post-hunt age and sex ratios varied little among years; age ratios ranged between 76 (90% C.I. \pm 26) and 77 (90% C.I. \pm 17) fawns per 100 does and sex ratios ranged between 20 (90% C.I. \pm 7) and 23 (90% C.I. \pm 5) bucks per 100 does. Our data also indicated low escapement of adult (\geq 2.5 years old) bucks that are legal to harvest under WDFW's 3-pt. minimum general hunting seasons. The number of adult legal bucks we estimated to be in the 2011 post-hunt population was only 247 (90% C.I. \pm 54) individuals.

Presenter: BROCK HOENES, Washington Department of Fish and Wildlife

A HABITAT SELECTIVITY INDEX FOR DESERT MULE DEER IN THE APACHE MOUNTAINS OF TRANS-PECOS, TEXAS

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Abstract: Habitat use of desert mule deer (*Odocoileus hemionus*) in the Trans-Pecos region of Texas is relatively unknown. We used ecological sites to construct a habitat selectivity index to identify habitat that may be preferred or not used by mature mule deer bucks. From 2006-2010 approximately 40 mature bucks (\geq 4.5 yrs. old) were captured using a helicopter and net gun from two study areas. One area was supplemental fed while the other was a non-fed site. Upon capture a global positioning system (GPS) radio collar was placed around the neck before being released. The radio collars were programmed to record each deer's location as well as a date and time every 5 hours. Deer were then recaptured annually to retrieve the GPS collars. Habitat availability was determined by the amount of each habitat type within an animal's 95% kernel home range while GPS locations were used to determine habitat use. Habitat use varied between the 2 study sites, but mule deer did select Draw sites more frequently in both areas. Draws, Gravelly, and Loamy ecological sites were regularly selected during the summer and fall while Limestone Hill and Mountains (Slope $<$ 60%) and Limestone Hill Mixed Prairie (Slope $<$ 20%) ecological sites were preferred during the spring and winter. Data suggest that deer may utilize areas that may not normally be preferred if supplemental feed stations are available in those areas.

Presenter: ANDY S. JAMES, Borderlands Research Institute

INFLUENCE OF WINTER FEEDING ON MIGRATION STRATEGIES OF ELK (*CERVUS ELAPHUS*) IN WEST-CENTRAL WYOMING.

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Abstract: Long-distance ungulate migrations are increasingly threatened as their routes become impeded by development or influenced by resource subsidies. The Wyoming Game and Fish Department operates 22 elk (*Cervus elaphus*) winter feedgrounds that are adjacent to native winter range. Feedgrounds were designed to shortstop migration by preventing elk from migrating to low elevation private land, but their influence on year-round migration behavior is unknown. Migration behavior may be influenced by altered nutrition provided by the winter feeding, or by the location of the feedgrounds as an attractant for migrating elk. We deployed GPS collars on 159 fed and 92 unfed elk from January 2007 to February 2012. Nutritional condition of fed and unfed elk, as estimated by percent body fat, was measured in mid-March 2011 with a subset of 20 fed and 19 non-fed elk. Surprisingly, differences in percent body fat between fed and unfed elk were not significantly different, although fed elk had slightly higher fat levels (fed = 6.11%, S.E. = 0.46; unfed = 4.89%, S.E. = 0.56; $p=0.065$). This difference, while slight, may still elicit differences in behavior. Body-fat differences did not influence forage time budgets on shared summer range (Feeding: 47% fed, 46% unfed, $p=0.75$). To evaluate migration behavior, we used net squared displacement to evaluate movement type (migration, home range, ambiguous) and visual inspection in ArcGIS to determine migration timing (onset, termination), rate of travel, distance traveled, stopover use and duration on summer ranges. A principal components analysis of timing metrics showed that migration patterns differ most in the arrival and departure from summer range. We focused on the arrival and departure from summer range using time to event modeling in Program MARK to account for the effects of climate, plant phenology, winter feeding and individual covariates on migration patterns. Transitional ranges and extended stopovers were common for both fed and unfed elk, but used by more fed elk. Unfed elk followed more of a typical migration with consistent, directional movement between seasonal ranges. In contrast, fed elk displayed erratic behavior, characterized by inconsistent, meandering movement and multiple commuting trips between seasonal ranges. In addition, fed elk spent less time on summer range by arriving later and departing earlier. These results suggest that although feedgrounds are conventionally thought to simply shortstop migrations, they appear to influence year-round migration behavior as well.

Presenter: JENNY JONES, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming



HYBRID SWARM BETWEEN DIVERGENT LINEAGES OF MULE DEER (*ODOCOILEUS HEMIONUS*)

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Abstract: Studies of hybrid zones have revealed an array of evolutionary outcomes, yet the underlying structure is typically characterized as one of three types: a hybrid zone, a hybrid swarm, or a hybrid taxon. Our primary objective was to determine which of these three structures best characterizes a zone of hybridization between two divergent lineages of mule deer (mule deer and black-tailed deer). These lineages are morphologically, ecologically, and genetically distinct, yet hybridize readily along a zone of secondary contact between the east and west slopes of the Cascade Mountains (Washington and Oregon, USA). Using microsatellite and mitochondrial DNA, we found clear evidence for extensive hybridization and introgression between lineages, with varying degrees of admixture across the zone of contact. The pattern of hybridization in this region closely resembles a hybrid swarm; based on data from 10 microsatellite loci, we detected hybrids that extend well beyond the F1 generation, did not detect linkage disequilibrium at the center of the zone, and found that genotypes were associated randomly within the zone of contact. Introgression was characterized as bidirectional and symmetric, which is surprising given that the zone of contact occurs along a sharp ecotone and that lineages are characterized by large differences in body size (a key component of mating success). Regardless of the underlying mechanisms promoting hybrid swarm maintenance, it is clear that the persistence of a hybrid swarm presents unique challenges for management in this region.

Presenter: JAMES R. HEFFELFINGER, Arizona Game and Fish Department

SELECTED RESULTS FROM RESIDENT AND NONRESIDENT MULE DEER HUNTER PREFERENCES SURVEYS CONDUCTED BY MONTANA FISH, WILDLIFE & PARKS

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Abstract: Following the 2010 general hunting season, FWP conducted surveys of resident and nonresident mule deer hunters to help evaluate Montana's mule deer management relative to hunting and harvest opportunities. Results from these surveys confirm that mule deer hunting is very important both resident and nonresident hunters. This tracks with the fact that deer hunting is by far the most popular hunting activity in Montana (in terms of overall numbers of deer hunters and hunter days). Overall, survey respondents were generally satisfied with the current mule deer hunting regulations and the timing of the current mule deer seasons in Montana. However, many resident mule deer hunters are concerned about a variety of hunting access related issues. Despite these concerns, respondent



reported being generally satisfied with overall mule deer hunting opportunities in Montana. Furthermore, nearly half of the respondents rated opportunities to hunt large mule deer bucks in the state as being better than average. Mule deer are truly one of Montana's premier big game species. FWP intends to use results from this survey as an important piece of information in the consideration of future management for this significant game species that is so highly prized by hunters in the state.

Presenter: MIKE LEWIS, Human Dimensions Unit of Montana Fish, Wildlife & Parks

PRELIMINARY OBSERVATIONS AND DISCUSSION ON ELK PARTURITION ABOVE TIMBERLINE IN NORTH-CENTRAL NEW MEXICO

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Abstract: As part of a larger study on elk calf survival and mortality patterns in North-central New Mexico, crews captured 245 elk calves from 2009-2012. Most adult female elk gave birth in lower elevation valley bottoms (~2,800-3,100 meters) that had greater concealment cover for calves in their "hider" stage. However, we also observed a unique behavior of some adult females selecting to give birth above timberline (~3,600-3,900 meters) in an alpine environment. We were unable to find discussion of this behavior in any scientific literature. This raises the question: why did some elk in this area choose to give birth in this alpine environment? Possible reasons behind this behavior include; heat stress, escape from biting insects, available food sources, predator avoidance, or a combination of these. If elk are moving to higher elevations due to heat stress, increasing temperatures in the southwest may drive more individuals to exhibit this behavior. In fact, an increasing number of terrestrial species are already shifting ranges in latitude or elevation in response to a changing climate. Elk may also be moving to higher elevations as snow melts and plants begin to green-up. Alternatively, since the major cause of death for all elk calves in our area was black bear predation, we will discuss whether elk born above timberline have a survival advantage. We hope the early results discussed in this presentation will encourage researchers to consider this newly identified behavior and gather more data on the potential impacts this may have on elk, the alpine habitat in this semi-arid region, and other alpine dwelling herbivores.

Presenter: STEWART LILEY, New Mexico Department of Game and Fish

ABUNDANCE, PRODUCTIVITY, CONDITION, AND SURVIVAL OF MOUNT ST. HELENS ELK, 2009-2013, AND CURRENT ELK MANAGEMENT CHALLENGES

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Abstract: We studied a high-density elk population at Mount St. Helens, WA to refine monitoring, quantify abundance, and assess productivity and survival, 2009-2013. We radiomarked 151 adult elk (111 F, 40 M), and we used the logit-normal mark-resight estimator (LNE) to estimate elk numbers each winter, 2009-2012, using 2 replicated helicopter surveys. We explored variation in abundance at 2 spatial and 2 demographic scales. Our LNE estimates suggested a population decline, but winter severity appeared to affect annual estimates. Cow subpopulation estimates ranged 4,451 to 3,758 elk, 2009-2012; a Lincoln-Petersen estimate for 2013 was 2,990. Estimates for the branch-antlered bull subpopulation were relatively stable, but with wide confidence intervals. Mid-winter pregnancy was modest (67%) in this population, and individuals appeared to be strongly food-limited; across years, mid-winter ingesta free body fat (IFBF) averaged 4.74-6.08% for non-lactators and 2.34-4.26% for fall lactators. We rarely (< 4%) detected pregnancy in elk with evidence of late lactation. Kistner subset scoring of organs from fall-harvested cow elk indicated mean IFBF estimates of about 10-13% for non-lactators and 8-12% for lactators, with spatial but not temporal variation clearly evident. Annual survival estimates for cows varied 0.55-0.85, with evidence of both spatial and temporal variation consistent with the harvest strategy in place 2009-2012; estimated mean bull survival was 0.54. Recently, segments of this herd have been increasingly affected by an ulcerative hoof disease with currently unknown etiology. We briefly describe recent work to better understand this condition, its impacts, and management options. Despite gains, this elk herd continues to present considerably complex management challenges.

Presenter: SCOTT MCCORQUODALE, Washington Department of Fish and Wildlife

EFFECTS OF HARVEST, CULTURE, AND CLIMATE ON TRENDS IN SIZE OF HORN-LIKE STRUCTURES IN TROPHY UNGULATES

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Abstract: In polygynous ungulates, mating success of males is correlated with body size and size of horn-like structures, which are biologically important and are of cultural interest. We evaluated trends in horn and antler size of trophy males recorded from 1900 to 2008 in *Records of North American Big Game*, which comprised >22,000 records among 25 trophy categories of species occupying North America. We used a weight-of-evidence approach based on differences among trophy categories in life-history characteristics, geographic distribution, morphological attributes, and harvest regimes to discriminate among competing hypotheses for explaining trends in horn and antler size of trophy ungulates. These hypotheses were young male age structure caused by intensive harvest of males, genetic change as a result of selective male harvest, a sociological effect, effects of climate, and habitat alteration. Trends in size of horn-like structures were negative and significant for 11 of 17 antlered categories and 3 of 8 horned categories. Mean predicted declines during 1950–2008 were 1.87 and 0.68% for categories of trophy antlers and horns, respectively. Our results were consistent with a harvest-based explanation, whereby harvest of males has gradually shifted age structure towards younger and smaller males. A harvest-induced reduction in age structure can increase the number of males that are harvested prior to attaining peak horn or antler size. Long-term trends in the size of trophy horn-like structures may provide the incentive to evaluate the appropriateness of the current harvest paradigm and pursue further investigations to disentangle the relative effects of nutrition and harvest.

Presenter: PAUL R. KRAUSMAN, Wildlife Biology Program, University of Montana

PERVASIVE HUMAN INFLUENCES IN A TERRESTRIAL FOOD WEB CENTERED ON ELK

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Abstract: Ongoing debate about whether food webs (e.g. those involving elk) are primarily regulated by predators or by primary plant productivity, cast as top-down and bottom-up effects, respectively, may become superfluous. Given that most of the world's ecosystems are human dominated we broadened this dichotomy by also considering human effects in a terrestrial food-web centered on elk. We therefore studied a multiple human-use system in southwest Alberta, Canada, as opposed to atypical protected areas where many previous terrestrial food web studies were conducted, which also had elk as dominant wild herbivore. Our system included humans, dominant predators (i.e., wolves) and prey (i.e., elk, but also domestic cattle) species, and herbaceous biomass (forage). Relationships were evaluated by taking advantage of pseudo-experimental temporal and spatial variation in human density, including: (a) day versus night, and (b) two landscapes with the highest and lowest human density in the study area. Here we show that forage-mediated effects of humans had primacy over predator-mediated effects in the food web. Spatial and temporal occurrence of humans was most correlated with occurrence of forage. Elk and cattle distribution were also correlated with forage, and the distribution of elk or cattle and wolves were positively correlated too. Our findings indicated that a number of studies on elk ecology and management that have typically focused on wild predators and natural plant communities should be re-interpreted. Humans now influence most food webs worldwide. Therefore, views of ecosystems focusing on forage-mediated effects of humans may subsume top-down or bottom-up views.

Presenter: Colleen Arnison, Masters Candidate, Faculty of Environmental Design, University of Calgary

INCORPORATING MOVEMENT BASED-LANDSCAPE CONNECTIVITY INTO ASSESSMENTS OF CHRONIC WASTING DISEASE RISK IN THE PRAIRIE PROVINCES OF CANADA

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Abstract: Chronic wasting disease (CWD) was first detected in free-ranging deer in Alberta in 2005 and is continuing to spread despite management efforts to contain the disease. To guide surveillance and management, we built a disease risk model (P_{IDM}) that predicted the probability of a hunter-harvested deer being CWD-positive based on deer species and sex, landscape characteristics, and connectivity to known sources of CWD using surveillance data collected in Alberta and Saskatchewan between 2000 and 2010. Landscape connectivity metrics were based on circuit theory and resistances derived from step-selection functions from movement responses of 58 GPS-collared deer. The best P_{IDM} included extent of agricultural area, ruggedness of the area, distance to stream and roads, and connectivity to disease sources, and had an area under the receiver operating curve (AUC) of 0.85. Metrics of landscape connectivity based on deer movement behavior improved the prediction of disease risk over proximity based on Euclidean distance. The model was used to identify areas of high risk in currently “CWD-free” wildlife management units (WMUs) in Alberta along the border of Alberta and Saskatchewan.

Presenter: EVELYN H. MERRILL, Department of Biological Sciences, University of Alberta

ELK CALF SURVIVAL AND THE EFFECTIVENESS OF BLACK BEAR REMOVAL IN NORTH-CENTRAL NEW MEXICO

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Abstract: We studied elk calf survival and the effectiveness of black bear removal from 2009-2012 in North-central New Mexico. Crews captured 245 elk calves during the birthing season across all years. Calves were captured by hand and equipped with a VHF ear-tag transmitter to aid in determining the causes and timing of mortalities. Calves averaged 2.6 days of age at capture and ranged from 0 to 6 days of age. We monitored calves daily during their first month of life and bi-monthly or monthly thereafter. Black bear populations were reduced on a portion of our study area in spring and summer during the second half of our study (2011-2012). We compared early (22-day) calf survival rates on treated and control areas both prior to and during bear removal. Prior to bear removal, the 22-day post-parturition survival rate was 53%. In contrast, when bears were actively being removed the 22-day survival rate on our treatment site increased to 70%. During this same time the survival rate on our control site was 58%. Black bears killed 25% of all marked calves during the first 22-days of life prior to removal, but only 15% of marked calves during removal on our treatment site. While bears were the most frequently identified cause of death across all years and treatments, they took proportionately less calves when they were actively being removed from calving areas. The second most frequently identified cause of death was coyote predation. Future work will assess whether bear predation acts as an additive or compensatory form of mortality in our study area.

Presenter: NICOLE TATMAN QUINTANA, Department of Natural Resources Management, Texas Tech University



EFFECTS OF HUNTER ACCESS AND HABITAT SECURITY ON ELK HABITAT SELECTION

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Abstract: Traditional elk habitat management on public land has focused on providing security habitat for bull elk during the hunting season in order to provide for both adequate hunter opportunity and bull survival. This paradigm has given less consideration to adult female elk habitat use, patterns of adjacent land ownership, and hunter access. This paradigm also was developed when elk population sizes were much smaller in many areas. In many Rocky Mountain states, the focus of elk population management has recently shifted to reducing or maintaining elk population sizes, necessitating a better understanding of the implications of security habitat management, as well as patterns of adjacent land ownership and hunter access, on adult female elk. We addressed this need by testing the hypotheses that during the hunting season: 1) adult female elk selection for areas prohibiting or limiting hunter access is stronger than elk selection for publicly owned and managed elk security habitat, 2) these effects occur during the archery hunting period and intensify during the rifle hunting period, and 3) the effects of hunter access on selection are consistent among herds that occupy landscapes characterized by a matrix of public and private lands. Elk selection for areas with limited public hunting access and lower motorized road densities, combined with either differential adult female harvest pressure on herd segments that use areas with public hunting access or elk avoidance of areas used by hunters, has the potential to reduce the number of elk using public lands. Our results provide evidence that in landscapes characterized by a matrix of public and privately owned lands, traditional concepts of elk security habitat need to be expanded to also include areas that restrict hunter access in order to plan for elk population management that is regulated through adult female harvest. These results reinforce the need for wildlife managers to work closely with public land management agencies and private landowners to manage the size of elk herds.

Presenter: KELLY M. PROFFITT, Montana Department of Fish, Wildlife, and Parks

RELATIVE IMPACTS OF ELK, MULE DEER, AND CATTLE ON ASPEN HABITAT IN THE BOOK CLIFFS, UTAH AND COLORADO

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Abstract: Quaking Aspen (*Populus tremuloides*) provide crucial habitat for a large array of forest dwelling and transient species. These systems, however, are threatened by multiple human impacts, such as clear-felling, land development, water diversions, fire suppression, and both wild and domestic ungulate herbivory. Aspen is the most widespread tree species in North America, yet particularly in the arid Southwest these forests may be highly sensitive to combined impact and climate effects. We undertook a landscape-level assessment of aspen forest conditions with the goal of identifying key components of resilience. Seventy-seven one hectare plots were sampled for forest structure, composition, regeneration and recruitment, landscape features, browse level, and herbivore use. Use was determined by counting pellet groups by ungulate species at each sample location. We also tested the efficacy of a visual stand condition rating system. Results indicate that plots differed significantly by seral or stable aspen type, stand condition, and browse species use. Overall, aspen in our study landscape was highly vulnerable to collapse due to narrow environmental limitations and browse levels. Ordination analysis revealed that regeneration level and herbivore use were the strongest objective indicators of aspen stand conditions, while the stand condition rating proved a valuable subjective index of forest status. Our results describe long-term, landscape-level, aspen herbivory impacts where naturally slow growth, relatively dry conditions, and intense browsing predominate. We argue for collaborative wildlife and forest management to promote ecosystem resilience and avoid further degradation of this regionally valuable and highly biodiverse habitat.

Presenter: PAUL C. ROGERS, Western Aspen Alliance, Ecology Center, and Wildland Resources Department

MODELING ELK NUTRITION AND HABITAT USE ACROSS LARGE LANDSCAPES: NEW METHODS OF META-ANALYSIS

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Abstract: Elk (*Cervus elaphus*) are widely distributed across the Northwest, where they are an integral component of the landscape. Elk management and land-use plans often rely on models that do not reliably estimate suitable elk habitat. In our presentation we describe development, validation, and application of new landscape models of elk nutrition and habitat selection during summer for western Oregon and Washington (Westside). We developed a unique meta-analysis approach that leveraged existing, disparate telemetry and environmental covariate data sets from a variety of sources. Specifically, we developed two models, both spatially explicit and applicable across large landscapes: a nutrition model to estimate elk diet quality, and a habitat use model to predict relative use by elk. We used an intensive model selection process that considered >50 covariates to create a suite of potential covariates for inclusion in the final models. The model best supported by the data included elk dietary digestible energy, distance to open roads, slope, and distance to cover-forage edge as covariates to predict probability of elk use. The habitat use model validated well, with correlation coefficients >0.85 in 5 of 8 validation sites. The models can be used to evaluate current conditions for elk in Westside landscapes and future conditions based on alternative from management scenarios such as reduced road access or forest canopy cover. Our methods of meta-analysis provide a regional inference space that typically has not been achieved with past modeling efforts and thus offer a defensible basis for regional management use of the models.

Presenter: MARY ROWLAND, U.S. Forest Service, Pacific Northwest Research Station

THE MONTANA DEER AND ELK HUNTING POPULATION: IMPORTANCE OF COHORT GROUP, LICENSE PRICE, AND POPULATION DEMOGRAPHICS ON HUNTER RETENTION, RECRUITMENT, AND POPULATION CHANGE

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Abstract: Big game hunting is an invaluable resource for outdoor recreation opportunities, an economic driver for state and local economies, and a mechanism for funding wildlife management. Unfortunately, hunting license sales have been in decline. Contrary to many other regions, Montana experienced



increased deer and elk license sales from 2002 – 2007. Despite this trend, understanding the mechanisms behind such increases, and diagnosing the persistence of such trends is necessary to anticipate license fund fluctuations. To address hunter recruitment and retention rates we analyzed >490,000 Montana deer and elk license records from 2002 – 2011. We used a mark-recapture framework to estimate hunter retention, recruitment, and population change, then used those estimates to forecast future hunter populations. Deer and elk hunter population size grew until 2006, and then declined because of dramatic reductions in hunter recruitment and decreases in hunter retention. Gender, age, and residency improved fit because of the overwhelming number of older resident male hunters that participate in hunting. Also, birth cohort and license price were valuable predictors that have ramifications for how Montana may structure recruitment and retention strategies. Recruitment of young hunters appears to be successful as recruitment has increased for this group, but because Baby Boomers are a majority of the hunting population, the loss of recruitment and retention from this class is driving declines in the hunter population.

Presenter: PAUL M. LUKACS, Department of Ecosystem and Conservation Sciences, College of Forestry and Conservation, University of Montana

MIGRATION BEHAVIOR, BODY CONDITION, AND SEX DIFFERENCES IN SURVIVAL OF MULE DEER.

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Abstract: Migration is an important adaptation for species inhabiting variable ecosystems. Many ungulate populations make seasonal migrations between summer and winter ranges; however, peer-reviewed literature indicates migration routes and distances travelled can be highly variable. Few studies have quantified these migration strategies in the context of true measures of fitness such as body condition or population-level effects on survival. We used data from 424 radio-collared mule deer (*Odocoileus hemionus*) to test hypotheses relating survival to body condition, sex, environmental conditions, and migratory strategy. We used a known-fate survival framework in Program Mark to obtain seasonal estimates of survival for each sex and age class in relation to body condition and migration distance. Adult survival was most parsimoniously explained by models containing covariates for sex, season, body condition and migration distance. Over-winter survival of juvenile mule deer was best explained by models containing covariates for sex, body mass, and a winter severity index. Adult and juvenile survival was lower for males than for females, even after accounting for mortality caused by human harvest. These results suggest population models may overestimate male survival outside of harvest reporting. We also provide preliminary results that suggest adult survival varies with respect to migratory behavior and body condition, which may have direct management implications for decisions affecting harvest quotas, habitat improvements, and energy development policies.

Presenter: CODY A. SCHROEDER, Department of Natural Resources and Environmental Science, University of Nevada



INFLUENCE OF FORAGING BEHAVIOUR ON HOME RANGE DEVELOPMENT IN ELK

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Abstract: Despite being documented across many taxa, home ranges and the mechanisms behind their development are not fully understood. The marginal value theorem combined with resource selection and memory has been proposed as a mechanism behind the emergence of stable home ranges, but these theories have seldom been tested. To explore the influence of foraging behaviour on home range, we investigated how a large browsing herbivore uses and returns to particular areas of its home range throughout the growing season. Using GPS radiotelemetry data from 20 elk (*Cervus elaphus*) and a spatial-temporal clustering algorithm, areas of foraging were identified within natural home ranges in montane grasslands of Southwestern Alberta. Vegetation surveys were used to evaluate and compare selected foraging patches to other areas of the home range visited but not selected for foraging. We have documented patch selection throughout the growing season, highlighting fidelity and a cyclic return pattern through areas of the summer range. Investigation into the mechanisms of stable home range development can help us to anticipate and understand changes in home range and how these ranges are influenced by conspecifics, competitors, invaders, and land-use change.

Presenter: DANA SEIDEL, Department of Biological Sciences, University of Alberta

ELK MOVEMENTS AND BRUCELLOSIS TRANSMISSION RISK IN SOUTHWEST MONTANA

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Abstract: The presence of *Brucella abortus* within free-ranging elk populations is an important conservation and management issue because of the risk of brucellosis transmission to livestock. In the winter of 2010-2011 Montana Fish, Wildlife and Parks initiated a multi-year targeted brucellosis surveillance project with the goals of delineating the geographical distribution of brucellosis in Montana



elk populations, enhancing our understanding of how brucellosis functions in elk populations and providing wildlife managers with information to inform elk management where brucellosis is present. During each of the winters of 2011, 2012 and 2013, we targeted brucellosis surveillance in a different study area along the periphery of where brucellosis had previously been detected. In each study area, 100 adult female elk were captured and tested for exposure to brucellosis, and 30 elk were outfitted with GPS collars. All seropositive elk were outfitted with radiocollars for 5 years, repeatedly captured and tested each year, and any pregnant seropositive elk were outfitted with vaginal implant transmitters to monitor the fate of pregnancy. During 2011, 12 elk in the Sweetwater/Blacktail herd tested positive for exposure to brucellosis, 4 were outfitted with VITS, and no abortions were detected. During 2012, 5 elk in the Sage Creek area tested seropositive, and 8 elk from the Blacktail and Sage Creek areas were outfitted with VITs. Two elk aborted calves in April and May of 2012, and the remaining 6 elk delivered live calves. In 2013, no elk in the Pioneer herd tested positive for exposure to brucellosis. A total of 7 VITS were deployed, and to date no abortions have occurred. *B. abortus* was cultured from tissues or VITs associated with each of the 2 aborted calves in 2012. Although seropositive elk abortion rates are relatively low, the risk of transmission to livestock does exist. GPS location data is being used to develop and validate predictive models forecasting elk and livestock spatial overlap during the risk period, and to help managers identify the areas of highest potential risk of elk to livestock transmission.

Presenter: JULEE SHAMHART, Montana Fish, Wildlife and Parks

EFFECTS OF SPRING CATTLE GRAZING ON THE NUTRITION OF MULE DEER IN A BLUEBUNCH WHEATGRASS COMMUNITY

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Abstract: Domestic cattle and mule deer (*Odocoileus hemionus*) share bluebunch wheatgrass (*Pseudoroegneria spicata*) communities throughout western United States and Canada, but the effects of cattle grazing on the nutrient intake and nutritional carrying capacity of mule deer in these semi-arid rangelands is unclear. We expected that spring cattle grazing would decrease plant biomass available but increase the nutritional quality of forage by arresting the phenology of grasses, reducing the proportion of standing dead biomass of grasses, and promoting forbs. Using exclosures, we created 3 replicates of paired grazed and non-grazed treatments within 3 pastures in bluebunch wheatgrass communities in southeastern Washington. After cattle had grazed 1 of each pair of plots to 40% utilization in April-May, we sampled the biomass and measured the digestible energy (DE, kJ/g) of plants that spring and fall. Using hand-raised, tractable mule deer, bite count methods, and behavioral observations, we measured intake within each plot. When compared to non-grazed plots, grazed plots



had less than half the total and live plant biomass in spring, and 25% less biomass in fall, whereas DE content of bluebunch wheatgrass and mule deer diets did not differ between grazing treatments. Daily DE intake of deer was lower in spring and fall in grazed than non-grazed plots, but nutritional carrying capacity did not vary between grazing treatments except for 1 pasture in fall, indicating that spring grazing by cattle in bluebunch wheatgrass communities did not improve the nutritional quality of deer diets enough to offset the overall loss of live forage biomass.

Presenter: LISA A. SHIPLEY, School of the Environment, Washington State University

WINTER HABITAT USE BY MULE DEER IN IDAHO AND MONTANA

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Abstract: Winter survival for Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) depends on an energy conservation strategy where they use habitats at lower elevations and south facing slopes with adequate thermal or canopy cover. However, not all mule deer habitats are equivalent; these and weather conditions contribute to differences in habitat use patterns and behavior among wintering populations. We studied mule deer on the East Front of the Rocky Mountains, Montana and Warm Springs and Sink Creek, east-central Idaho to determine how weather and vegetation affect winter habitat use. We located radiocollared adult female mule deer and collected data on weather, landscape, cover and forage variables at deer use and random locations during winter 2010–2011. Using logistic regression, we found that deer use different habitat components on these different winter ranges. On the East Front, a combination of variables predicted probability of deer use, mainly related to cover, forage, and environmental conditions. Covariates changed in magnitude depending upon weather conditions and deer behavior. In Idaho, cover and forage variables were important predictors of mule deer habitat use. Mule deer habitat use also differed between Idaho study areas. In Warm Springs, covariates related to foraging predicted habitat use whereas in Sink Creek, covariates related to thermal or hiding cover predicted habitat use. Differences among all 3 study areas indicate that deer use different habitat components under different winter conditions. Discrepancies in habitat use among winter ranges are important when considering habitat requirements of mule deer.

Presenter: SONJA M. SMITH, Montana Fish, Wildlife and Parks

NUTRITIONAL CONDITION OF ADULT MULE DEER FOLLOWING HABITAT ENHANCEMENTS IN NORTH-CENTRAL NEW MEXICO

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Abstract: Mule deer (*Odocoileus hemionus*) populations are declining throughout the western United States including New Mexico. Poor quality habitat, food availability, drought, and predation are factors indicated to limit mule deer populations in north-central New Mexico. The 33,000 acre National Rifle Association Whittington Center (WC) located south of Raton, NM implemented a habitat enhancement program intended to benefit mule deer. The objectives of this study were to determine the nutritional condition of mule deer and cause-specific mortality following habitat treatments. We radio marked 36 and 16 adult mule deer during the winter of 2011 and 2012 respectively. Each deer was monitored daily for survival and cause-specific mortality was determined for each death. Here we report on live animal indices including: body condition score, subcutaneous rump fat, body mass, chest girth, and total body length. Total ingesta-free body fat (IFBF) levels of adult deer in March ranged from 1.05% to 10.55%. Body mass ranged from 42.18 kg to 70.31kg. Predation was the most common cause of mortality (85% $n=22$) and mountain lion (*Puma concolor*) accounted for 68.2% of all predation events. There was no significant correlation ($p=0.3188$) between IFBF and fate of adult mule deer thus indicating a weak role of IFBF in the mortality of mule deer on the WC. Our IFBF levels are congruent to those recorded on similar studies in the area prior to habitat enhancements. These results point to a stronger role of predation over nutritional condition in the survival of adult mule deer in north-central New Mexico.

Presenter: GRANT E. SORENSEN, Department of Natural Resources Management, Texas Tech University



HABITAT ENHANCEMENT STRATEGY CHANGES IN ELK COUNTRY

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Abstract: The Rocky Mountain Elk Foundation (RMEF) over the past 28 years has provided grants for wildlife habitat enhancement projects on federal, state, tribal and private ownerships. The types of projects funded in the 1980s and 1990s were primarily prescribed burns and noxious weed treatments and most focused on the crucial winter ranges or winter range as delineated by the state wildlife agencies. The collective thinking at the time was that summer range was virtually unlimited and the winter range conditions were a limiting factor in getting elk through the rigorous winters of the western landscape. In the early 2000s the collective thinking shifted to the importance of transitional ranges for elk to maximize their body condition post-rut and before the winter conditions arrived. Habitat treatment projects continued to focus on winter ranges while some shifted to the transitional areas. Forests were even-aged with an understory of ladder fuels that lead to stand replacing fires in most conifer types. The primary habitat enhancement tool was forest thinning by mechanical means. New research on elk nutrition pointed out the importance of summer range nutrition and its impact on breeding success, pregnancy rates and winter survival were identified. Use of the most recent science has directed the emphasis on wildlife habitat enhancement and developing science should drive future enhancement projects.

Presenter: TOM TOMAN, Rocky Mountain Elk Foundation

GENETIC STRUCTURE AND DIVERSITY OF ELK (*CERVUS ELAPHUS*) IN WASHINGTON STATE

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Abstract: Elk in Washington State are divided into ten “herds,” and include Roosevelt and Rocky Mountain subspecies. Roosevelt elk are native, found on the Olympic Peninsula and in the southwest portion of the state. Although Rocky Mountain elk historically may have been native in Washington, existing populations in the Cascade, Blue, and Selkirk Mountains are now composed mostly of elk that are descendants of animals translocated from Montana and Wyoming. We examined the genetic structure and diversity of these elk populations using nine microsatellite loci, each with an average of six alleles per locus. Except for Mount St. Helens, herds are generally composed of either Roosevelt (two herds) or Rocky Mountain elk (seven herds); the Mount St. Helens herd includes both subspecies. There is significant genetic differentiation between the Roosevelt and Rocky Mountain herds, although elk from North Cascade herd, considered to be Rocky Mountain elk, appear equally distant genetically from all herds. If we ignore the geographic distribution and consider only genetic differentiation, Roosevelt elk are distributed as two populations: north and south, corresponding to the Olympic and Willapa Hills/Mount St. Helens herds, respectively. Although the Rocky Mountain elk are more widely



distributed geographically than Roosevelt elk, genetically they resemble a single population, perhaps reflecting the recency of their translocations. Despite the genetic similarity among all Washington Rocky Mountain herds, elk from the contiguous Mount St. Helens, Yakima, and North and South Rainier herds are more similar genetically to each other than they are to the other Rocky Mountain herds.

Presenter: KENNETH I. WARHEIT, Washington Department of Fish and Wildlife

UNTANGLING ROCKY MOUNTAIN ELK ECOLOGY AND POPULATION DYNAMICS: A REGIONAL SYNTHESIS ACROSS THE NORTHWESTERN U.S.

WESTERN ELK RESEARCH COLLABORATIVE (representatives from 7 state wildlife management agencies, 4 Cooperative Wildlife Research Units, 1 university, National Park Service)

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Abstract: The Western Elk Research Collaborative (WERC) is a group of state and federal biologists and university faculty that is pooling Rocky Mountain elk data from 7 states to understand factors affecting elk population dynamics at broad spatial and temporal scales. These “value-added” analyses leverage the considerable investment collaborators made to develop their respective datasets. Our initial efforts pooled data from 12 elk populations to evaluate calf survival and cause-specific mortality (Journal of Animal Ecology 80:1246-1257) and 45 datasets to assess adult female survival and cause-specific mortality (Journal of Applied Ecology in press). We will briefly describe those findings. We also seek to understand how reproductive output varies across space and time as a function of factors such as weather, plant productivity, and predation. Therefore, we are assembling population and reproduction data from our 7 state study area. The spatial and temporal (up to 25 years) scales are unique and may provide insight into the effects of climate change on elk population dynamics. As a direct result of the exceptional cooperation and communication among collaborators ... a signature success of WERC ... we are developing an unprecedented Rocky Mountain elk dataset that will provide a fertile arena to investigate relevant management and research questions.

Presenter: PETE ZAGER, Idaho Department of Fish and Game

Abstracts – Poster Session, 2013

Alphabetical by Senior Author



THE ENVIRONMENTAL-DATA AUTOMATED TRACK ANNOTATION (*ENV-DATA*) SYSTEM: LINKING ANIMAL TRACKS WITH ENVIRONMENTAL DATA

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Abstract: The movement of animals is strongly influenced by external factors in their surrounding environment such as weather, habitat types, and human land use. With advances in positioning and sensor technologies, it is now possible to capture animal locations at high spatial and temporal granularities. Likewise, modern technology provides us with an increasing access to large volumes of environmental data, some of which changes on an hourly basis. Environmental data are heterogeneous in source and format, and are usually obtained at different scales and granularities than movement data. Indeed, there remain scientific and technical challenges in developing linkages between the growing collections of animal movement data and the large repositories of heterogeneous remote sensing observations, as well as in the developments of new statistical and computational methods for the analysis of movement in its environmental context. These challenges include retrieval, indexing, efficient storage, data integration, and analytical techniques. We have developed a new system – the Environmental-Data Automated Track Annotation (*Env-DATA*) – that automates annotation of movement trajectories with environmental information, including high resolution topography, weather from global and regional reanalysis datasets, climatology, human geography, ocean currents and productivity, land use, vegetation and land surface variables, precipitation, fire, and other global remote sensing datasets. The system automates the acquisition of data from open web resources of remote sensing and weather data and provides several interpolation methods from the native grid resolution and structure to a global regular grid linked with the movement tracks in space and time. We also develop research tools that facilitate interpretation of these combined ecological-environment datasets. *Env-DATA* provides an easy-to-use platform for end users that eliminates technical difficulties of the annotation processes, including data acquisition, data transformation and integration, resampling, and interpolation. The new *Env-DATA* system enhances Movebank (www.movebank.org), an open portal of



animal tracking data. The system is open and free to any user with movement data. The aim is to facilitate new understanding and predictive capabilities of spatiotemporal patterns of animal movement in response to dynamic and changing environments from local to global scales.

IMPACT OF RECOLONIZING GRAY WOLVES ON MULE AND WHITE-TAILED DEER IN WASHINGTON

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Abstract: Gray wolves are rapidly recolonizing Washington state. Our study seeks to understand the impacts that the return of a large carnivore can have on mule and white-tailed deer in north-central Washington. The study is examining both consumptive (e.g., fawn and adult survival) and non-consumptive (e.g., shifts in behavior and habitat use) effects of wolves on both deer species using wolf and non-wolf study areas within a multi-use landscape. Long and short-term data is being collected in the form of remote camera grids, GPS collars, and GPS camera collars.

MULE DEER POPULATION IN THE MAPIMI BIOSFERE RESERVE, CHIHUAHUAN DESERT, MEXICO.

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Abstract: Mule deer (*Odocoileus hemionus*) has been studied in the Mapimí Biosphere Reserve (MBR), Durango, Mexico, in the Chihuahuan Desert, because of its importance as an herbivore and hunting resource, sharing this habitat with cattle under extensive management. During 1996-1997 using an indirect method as counting fecal groups in 8 transects of 800 m, the estimation density was considered very low (between 2 and 3 deer / km²). In 2006-2007 the same sites were sampled estimating a density between 4 and 6, although during the 2010 -2011 average was 3 deer / km². During 2010 and 2011 to



know if there is spatial competition between deer and cattle, fecal groups were obtained in the same transects for both species. The average was 86.58 deer fecal groups / ha (3.33 ± 0.97 ; range 1.54-4.09 deer / km²) and 32.21 cattle fecal groups/ ha (2.39 ± 0.98 ; range 1.24-3.65 cows / km²). Measures of habitat variables such as visibility, slope, elevation and vegetation were also taken. Correlations of habitat variables with density ratios and principal component analysis (PCA) were used to identify the most important: the volume of vegetation and visibility for one component, the density and the slope for the component two. There were found differences in habitat use between deer and cattle related to the slope, altitude and vegetation cover.

MAPPING INTERACTIONS OF ELK, MULE DEER HUNTERS, AND ATVS DURING HUNTING SEASONS IN NORTHEAST OREGON.

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Abstract: Hunting has been a traditional form of recreation in North America, but developing technologies and changing land use have led to discussions among land and resource managers and various public groups on how to adapt to these developments. At the same time, elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) populations are declining in many areas, while demand for recreational opportunities remains high. Growing use of all terrain vehicles (ATV) by hunters and recreationists has led to debates over how to best manage this activity for public lands and wildlife. Since 2008, researchers at the Starkey Experimental Forest and Range in northeast Oregon have manipulated ATV access by creating a gradient of open and closed roads and ATV trails and have used GPS units with high frequency relocations to record elk, mule deer, hunter, and ATV movements during three fall hunts: archery elk (late August-early September), rifle deer (late September-early October), and rifle elk (late October-early November). Having location data for these components will help answer key questions. Do elk and mule deer avoid areas heavily used by ATVs? Do hunters have greater success when they use ATVs? Not only is animal behavior captured with GPS data, but now hunter behavior is also being recorded. How much time do hunters spend away from their ATVs? How far from roads and access points do hunters travel? Characterizing and quantifying interactions between hunters, ATVs, mule deer, and elk may provide managers with information to better manage public lands, ATVs, and hunters.



LINKING SURVIVAL AND RESOURCE SELECTION BY FEMALE WHITE-TAILED DEER WITH DIFFERENT MIGRATION STRATEGIES

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Abstract: After two harsh winters that reduced the white-tailed deer (*Odocoileus virginianus*) population in eastern Washington and a public initiative to change harvest regulations, the Washington Department of Fish and Wildlife implemented a study to improve understanding of the population. Our study focuses on how seasonal movements and survival rates affect estimates of seasonal resource selection by female whitetails. We are also examining the broader questions of what factors contribute to the distribution of white-tailed deer at the western edge of their geographic distribution and the effects of different migratory strategies on survival. We are using locations from global positioning system (GPS) and very high frequency (VHF) radio collars and ear tags to create seasonal resource selection functions (RSFs). We are linking survival estimates generated from collar data to the RSFs to evaluate what parts of the study area contribute most to high survival of whitetails during different seasons (Adult $S = 0.698$ $SD = 0.082$, Yearling $S = 0.712$ $SD = 0.104$, Fawn (6 month+) $S = 0.932$ $SD = 0.119$). We are also examining how land cover type and land use by humans affect the spatial dynamics of this widely distributed species. Wildlife managers will be able to use the information we generate in setting land use and harvest regulations to effectively manage whitetail populations at targeted levels.

SEASONAL HOME RANGES OF DESERT MULE DEER IN THE APACHE MOUNTAINS OF THE TRANS-PECOS REGION OF TEXAS

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Abstract: Desert mule deer (*Odocoileus hemionus*) are a prominent animal in Texas, but limited research has been conducted on them in the Trans Pecos region of the state. From 2006-2010 approximately 40 mature bucks (≥ 4.5 yrs. old) were captured using a helicopter and net gun from two study areas. One area had supplemental feeders while the other was a non-fed site. Once the deer were captured the age and antler measurements were recorded, and a global positioning system (GPS) radio collar was placed around the neck before being released. The radio collars were programmed to record each deer's location as well as a date and time every 5 hours. Deer were then recaptured annually to



retrieve the GPS collars, and measure antler development. The data suggests that home ranges are much larger than previously estimated. Using the fixed kernel home range analysis tool with a 95% confidence level, home ranges for mature mule deer averaged 35.3 km² on the supplemental fed site and 45.0 km² on the non-fed site with a range from 20.5 km² to 96.2 km². Home ranges during the winter (includes the rut) was more than double the size of any other season (spring, summer, fall). Data also shows that deer move less during the fall than any other season. With the completion of this project, understanding mule deer annual and seasonal home ranges will allow biologist to make better recommendations on how to manage mule deer in the Trans Pecos.

HABITAT USE OF MULE DEER ON AGRICULTURAL LANDS: IMPLICATIONS FOR SURVIVAL AND REPRODUCTION

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Abstract: Extensive use of agricultural lands by deer is common throughout the west, especially in desert environments where native forage and water is limited. Artificially high densities of deer on fields can lead to increased disease risk due to close association with livestock and conspecifics. Also trace mineral or nutritional imbalances may result from inability to digest a diet comprised primarily of alfalfa, a high energy, high protein forage, resulting in sickness or decreased body condition. For these reasons agricultural fields have the potential to act as a population sink. We have monitored habitat use, survival and occurrence of disease symptoms (diarrhea and emaciation) for deer associated with agricultural fields. We have identified 3 strategies for use where animals either; remain in the uplands throughout the spring and summer, remain in the uplands through the spring and early summer than transition to the fields during late summer, or remain on the fields throughout the spring and summer. We have identified variation in seasonal use of agricultural lands with greater numbers of individuals using the fields as the summer progresses and increasing numbers of symptomatic individuals during late summer and fall. We have also identified higher iron and molybdenum levels in the livers of sick individuals, which can cause secondary copper deficiencies and result in disease symptoms. Using this information we can identify how habitat relationships influence health and subsequent survival.

EFFECTS OF NATURAL GAS DEVELOPMENT ON NEONATAL MULE DEER MORTALITY

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Abstract: Extensive natural gas development on public lands has elevated concern among public stakeholders, wildlife managers, and researchers about the impacts on wildlife. Impacts on mule deer (*Odocoileus hemionus*) populations and their habitat are of particular interest due to the deer's recreational, social, and economic importance as a game species. Understanding neonatal mule deer fawn survival and cause-specific mortality is critical to properly managing mule deer populations, especially where natural gas development disturbances are occurring. The intensity of disturbance from development may be directly negatively correlated with neonate survival, or indirectly correlated through changes to habitat. However, no published studies have quantified the effects of natural gas development disturbances and consequent habitat conversion on neonatal fawn survival. In fact, only with recent technological innovations, is the ecology of the neonate life stage being illuminated and much general biology still needs to be described. We propose to provide neonatal mule deer fawn survival estimates related to energy development, neonate, dam, and temporal characteristics, and assess cause-specific mortality. Estimates of survival and cause-specific mortality will be derived from a sample of neonates captured from 2012-2014 using vaginal implant transmitters inserted in dams ($n = 360$) and subsequent attachment of radio telemeters on neonates. In addition, we will assess habitat characteristics of neonate birth and mortality sites. We will compare characteristics of these sites to random sites to assess habitat selection and patterns in mortality occurrence. Overall, our goal will be to provide results promoting improved energy development mitigation and wildlife management practices.

TOP-DOWN VERSUS BOTTOM-UP FORCING: EVIDENCE FROM MOUNTAIN LIONS AND MULE DEER

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Abstract: We studied mountain lions (*Puma concolor*) and mule deer (*Odocoileus hemionus*) inhabiting a Great Basin ecosystem in Round Valley, California, USA, to make inferences concerning predator-prey dynamics in that system. Our purpose was to evaluate whether the mule deer population was affected more by top-down or bottom-up processes, and thereby assess the applicability of the “world is green” or the Hairston, Smith, and Slobodkin (HSS) hypothesis. We identified a period of decline for mule deer (1984-1990), and then a period of slow but steady increase (1991-1998). For mule deer, bitterbrush (*Purshia tridentata*) in diets, per capita availability of bitterbrush, kidney fat indices, fetal rates, fetal weights, and survivorship of adults and young indicated that the period of decline was typical of a deer



population near the carrying capacity (K) of its environment. The period of increase was typified by deer displaying characteristics of a population below K , but the finite rate of growth ($\lambda = 1.10$) did not reach what would be expected for a population rapidly rebounding toward K ($\lambda = 1.15$ - 1.21). These outcomes indicated that top-down and bottom-up forcing is a poor dichotomy—we observed both processes in the same population of deer. Moreover, we conclude that the HSS hypothesis is too broad and sweeping to encompass complex predator-prey dynamics, and may not be as useful as once thought for characterizing trophic dynamics for ecosystems in which large mammals are important components of food webs.

THE WESTERN ASPEN ALLIANCE: PROMOTING SUSTAINABLE ASPEN ECOSYSTEMS IN WESTERN NORTH AMERICA

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Abstract: The Western Aspen Alliance (WAA) is a consortium of managers, researchers, conservationists, and the public interested in science-based sustainable management. Recent events have spurred interest in aspen ecology. For example, reports of sudden aspen mortality, large-scale seedling establishment following wildfires, and documentation of trophic interactions between wolves, elk, and aspen, have significantly modified our understanding of aspen ecosystems. An aging aspen regional cohort must successfully regenerate to maintain sustainable populations. Wildlife pressure on aspen regeneration is an issue of concern for managers throughout the western United States. The WAA will incorporate current science into an ongoing resource bank for managers throughout the region. From a research perspective, we wish to engender a cross-disciplinary network of researchers willing to take on pertinent aspen topics. For example, there is a current need to assess the extent of Sudden Aspen Decline (SAD), seral/stable aspen coverage, water conservation, and historic aspen extent and change. Basic research on aspen physiology, disturbance ecology, water yield, genetics, herbivory, and biodiversity/trophic interactions issues are also desired. The social/aesthetic value of aspen is an emerging research area. We will form working groups for these issues and pursue additional aspen topics that arise. A central role of the WAA is to sponsor field visits, workshops, conferences, and collaboration between researchers. We have compiled a bibliographic database (+7,000 records) of aspen research and management topics for use by WAA members. We are currently working with numerous state and federal agencies, NGO's, and universities. We welcome your input and participation!

NEXT GENERATION MODELS FOR ELK ON BLUE MOUNTAINS SUMMER RANGE

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Abstract: Elk (*Cervus elaphus*) are widely distributed in Oregon and Washington, where they are a valued resource providing hunting and viewing opportunities and contributing substantially to rural economies. Elk also function as a keystone species that influences plant community development and other ecosystem processes. Current habitat management for elk across much of Oregon and Washington relies heavily on guidelines developed decades earlier, when scant empirical data were available to inform the models on which the guidelines relied. Spatially explicit models that predict nutritional resources and relative use of elk on multiple land ownerships can help inform cohesive and strategic management of elk populations and their habitats. We developed new regional nutrition and habitat use models for elk for application on elk summer range in the Blue Mountains of eastern Oregon and Washington. We developed a unique meta-analysis approach for modeling that leverages existing telemetry and environmental covariate data from a variety of sources. The stand-alone nutrition model predicted elk dietary digestible energy based on potential vegetation type, percent canopy cover, precipitation, and date. The nutrition model output served as one input covariate to the habitat use model. Other covariates of the habitat use model included slope, distance to roads, and percent area in forested vegetation. The nutrition and habitat use models incorporate readily available spatial data layers and can be used to evaluate current conditions for elk or to predict future conditions under an array of management alternatives.

COMPARISON OF GENDER AND ITS EFFECTS ON TOOTH WEAR ACCURACY ON ELK IN MICHIGAN

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Abstract: Accurate determination of age in harvested species is critical for estimating population trends and modeling abundance to achieve management objectives. We used the tooth wear aging method to accurately age 1,212 of 3,005 (40.3%) harvested elk (*Cervus elaphus*) in Michigan, 1964 - 2007. In contrast, Hamlin et al. 2000 had about 50% agreement. Our accuracy although lower could potentially be associated to our large sample size and the presence of older age classes within our sample. Accuracy in the tooth wear aging method in adult elk in Michigan differs with respect to gender. Male accuracy (44.69%) for the tooth wear aging method was higher than females (36.99%). This is opposite of our original hypothesis and conflicts with Van Deelen et al. 2000 findings in white-tailed deer. We do not recommend using the tooth wear method if precise age estimates are necessary for population models.